

A CAHNERS PUBLICATION

INTERNATIONAL EDITION

MAY 1, 1986

EDN

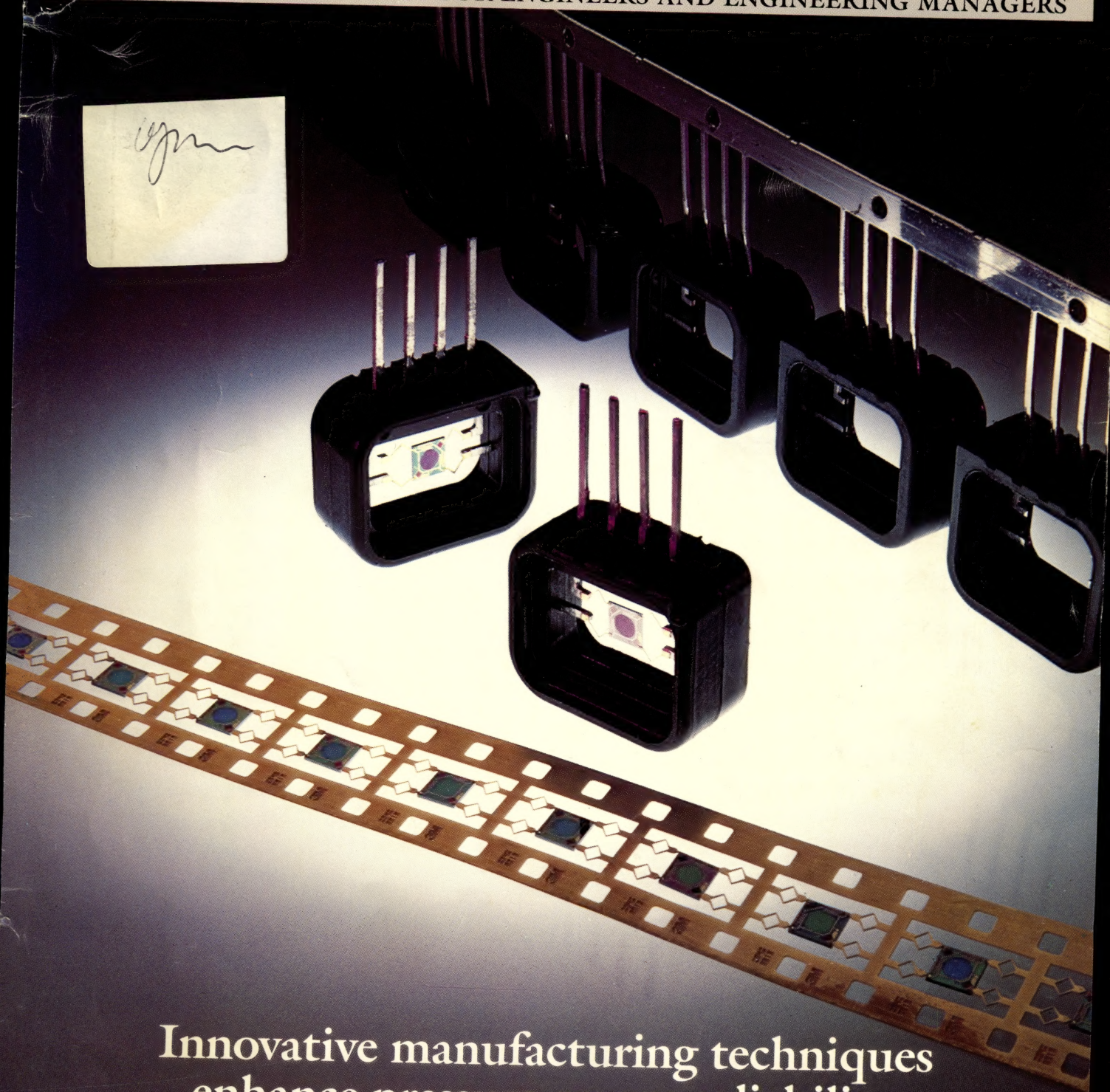
**ELECTRO/86 PREVIEW:
SESSIONS & PRODUCTS**

Subsystem buses for the
VME Bus and Multibus II

Driver ICs for
plasma and EL displays

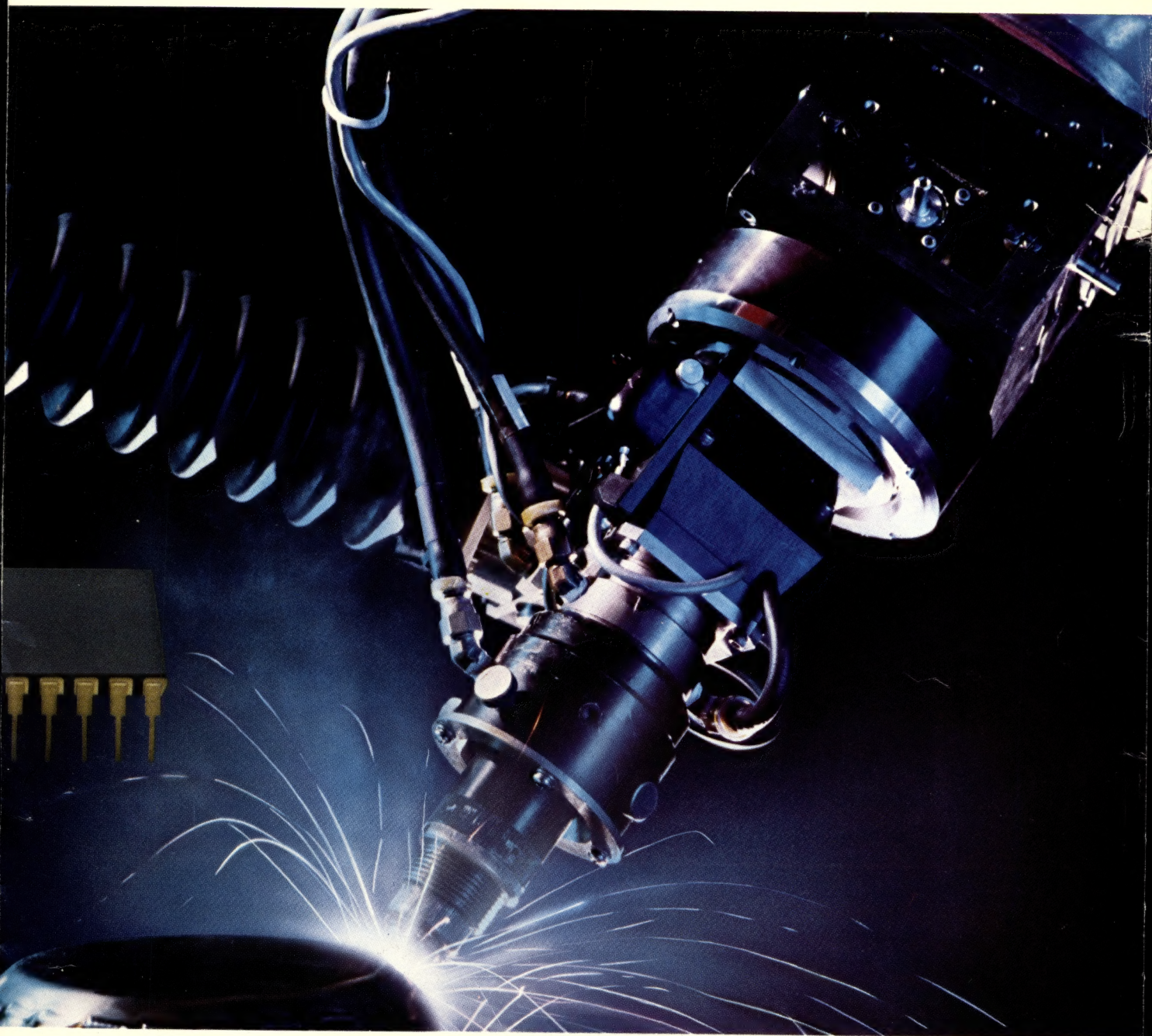
Winchester disk testers

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**Innovative manufacturing techniques
enhance pressure-sensor reliability**

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error correction technique, the ICL7134 provides up to 14 bits of accuracy and ultra-high stability over the entire operating temperature range. Plus the same cool low-power CMOS performance.

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Our ICL7115

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INTERSIL
ICL7115

The only 14-bit monolithic A/D converter on the market today—that's Intersil's ICL7115. It's the chip that will change the definition of signal processing.

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The key to the ICL7115 is our proprietary

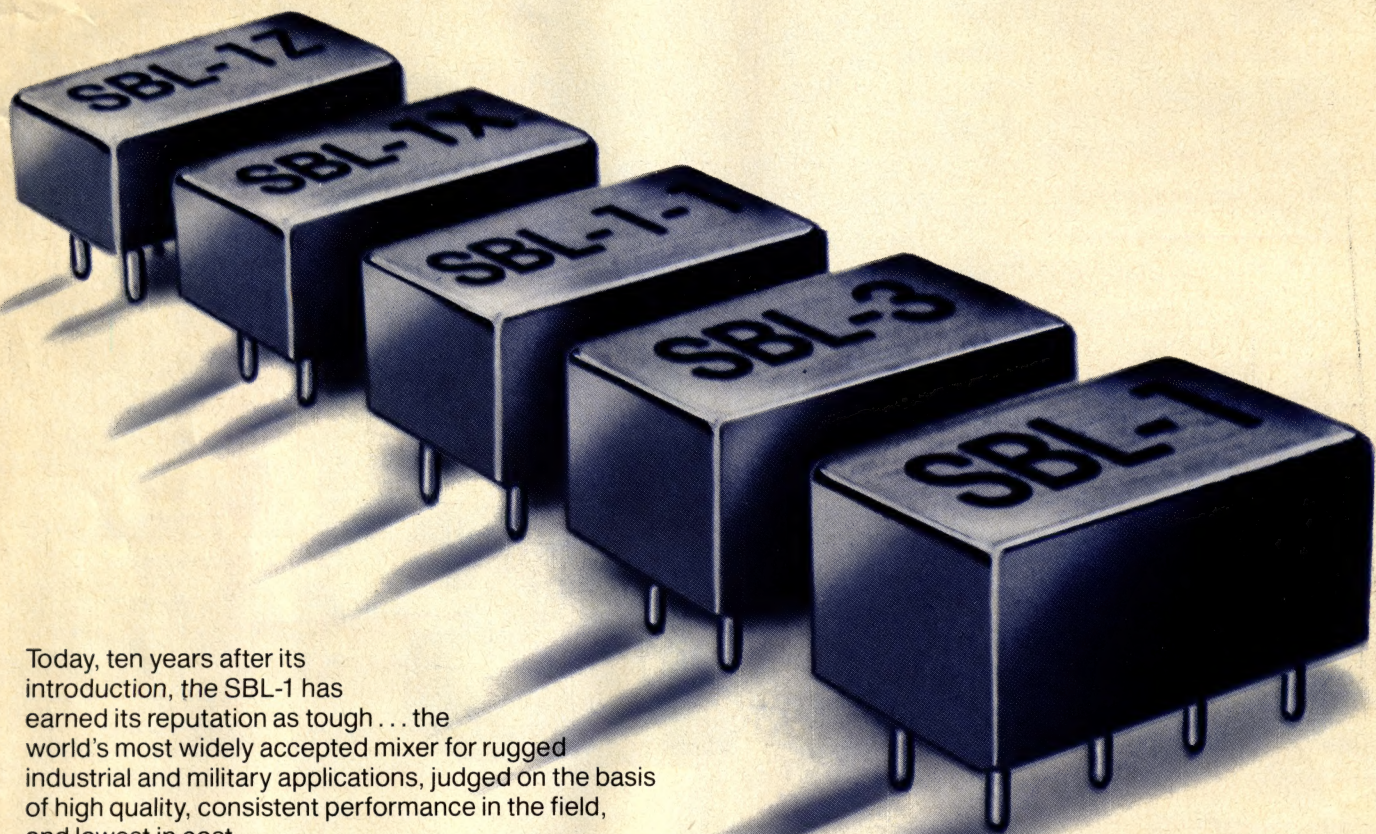
EPROM error correction technique. Unlike conventional techniques such as laser trimming, this unique EPROM correction method compensates for linearity and full-scale error with greater precision and stability, over the entire operating temperature range.

Though it's a hot new product, the ICL7115 is a very cool performer: thanks to our advanced CMOS technology, the whole package dissipates only 10mW.

And if your system requires equal precision in a D/A converter, our ICL7134 meets the challenge. Utilizing the same proprietary EPROM

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Model	Freq. (MHz)	Conv. Loss	Isolation, dB		Price (10-49)
			L-R	L-I	
SBL-1	1-500	5.5	45	40	\$4.50
* SBL-1X	10-1000	6.0	40	40	\$5.95
SBL-1Z	10-1000	6.5	35	25	\$6.95
SBL-1-1	0.1-400	5.5	35	40	\$6.50
SBL-3	0.25-200	5.5	45	40	\$7.50

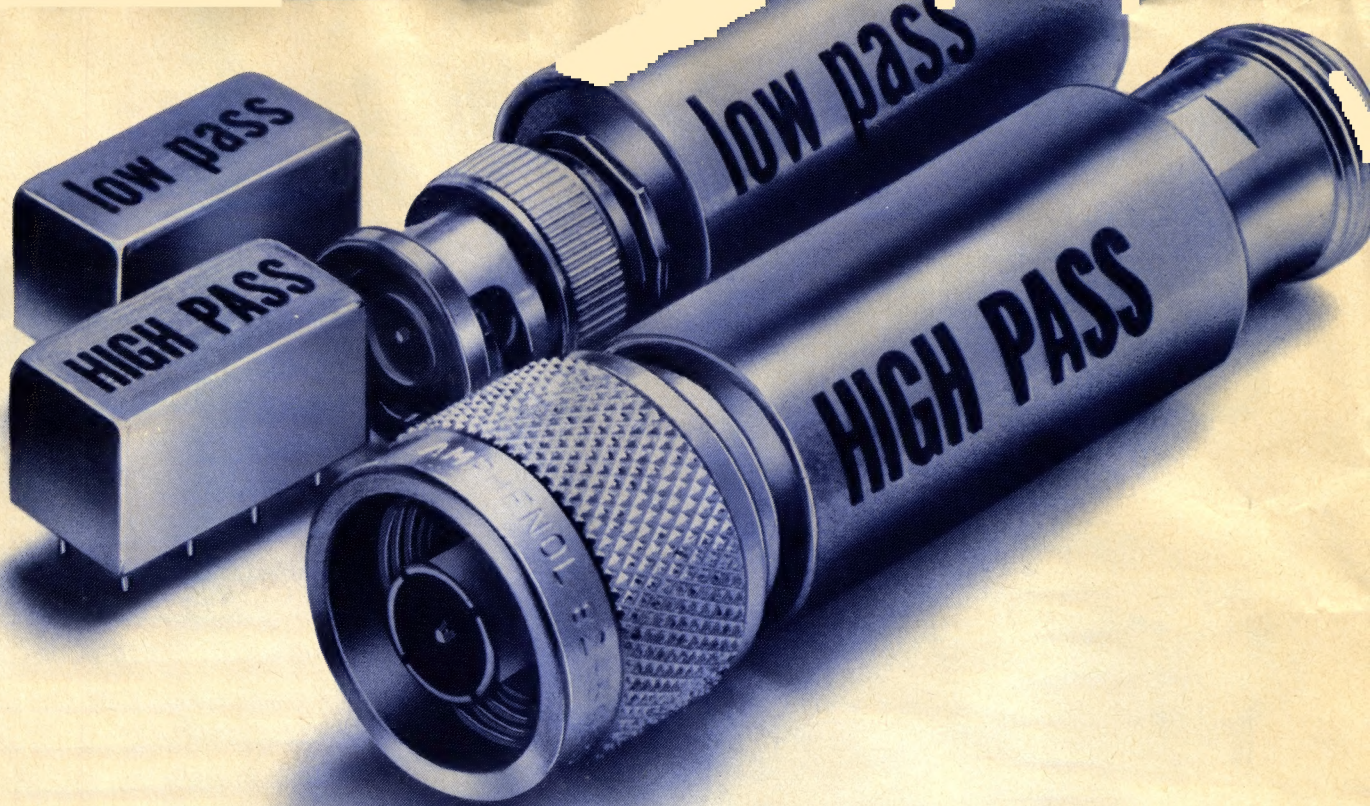
* If not DC coupled.

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LOW PASS	Model	*LP-	10.7	50	100	150	200	300	450	550	600	750	850	1000
Min. Pass Band (MHz) DC to			10.7	48	98	140	190	270	400	520	580	700	780	900
Max. 20dB Stop Frequency (MHz)			19	70	147	210	290	410	580	750	840	1000	1100	1340

Prices (ea.): **P** \$9.95 (6-49), **B** \$24.95 (1-49), **N** \$27.95 (1-49), **S** \$26.95 (1-49)

HIGH PASS	Model	*HP-	50	100	150	200	300	400	500	600	700	800	900	1000
Pass Band (MHz) start, max.			41	90	133	185	290	395	500	600	700	780	910	1000
end, min.			200	400	600	800	1200	1600	1600	1800	2000	2100	2200	
Min. 20dB Stop Frequency (MHz)			26	55	95	116	190	290	365	460	520	570	660	720

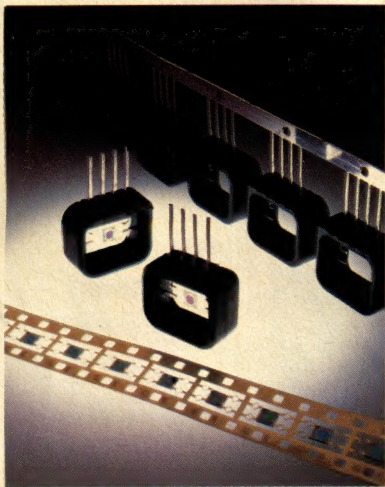
Prices (ea.): **P** \$12.95 (6-49), **B** \$27.95 (1-49), **N** \$30.95 (1-49), **S** \$29.95 (1-49)

*Prefix **P** for pins, **B** for BNC, **N** for Type N, **S** for SMA

example: **PLP-10.7**

CIRCLE NO 21

C105 REV. ORIG.



On the cover: Manufacturers of pressure sensors are using new fabrication techniques (such as the tape-automated-bonding procedure) to improve device reliability. In addition, they're miniaturizing their products and offering complex circuitry within the transducer package itself. See pg 100. (Photo courtesy Micro Switch)

DESIGN FEATURES

Special Report: Pressure Sensors and Transducers

100

Designers of pressure sensors and transducers are striving to improve price and performance figures to satisfy the needs of a growing variety of applications. In particular, the levels of integration now available in IC-based devices are maintaining performance levels while reducing costs.—*Tom Ormond, Senior Editor*

Electro/86

123

Electro/86 and its companion show, Mini/Micro Northeast, will highlight a slew of high-performance board-level products as well as new support ICs for 32-bit μ Ps.—*Charles H Small, Associate Editor*

Electro/86 Products

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Low-cost buses add industrial I/O to VME, Multibus II

175

Links to an 8- or 16-bit I/O subsystem prove a cost-effective solution to providing data-acquisition and industrial-control interfaces for VME and Multibus II systems. This article describes cards that you can link in an I/O subsystem bus.—*Peter Harold, European Editor*

Port technique allows complex-impedance emulation and scaling

205

Using a quad op amp and discrete components, you can create a bi-directional port that's terminated by an arbitrary complex impedance. Single-ended and balanced versions are based on a single network of passive components.—*Howard Sinberg, Aptek Microsystems*

Innovative designs yield small, efficient switchers

223

Designing switching power supplies isn't always a routine job. Sometimes your specifications call for special supplies of extremely small size combined with very high efficiency and the ability to accept wide variations in input voltage.—*Stephen S Banfalvi, Bell Northern Research*

Designer's Guide to: Linear control-system theory—Part 3

239

You can use a dynamic signal analyzer's built-in waveform-math functions to derive the open-loop frequency response of a system from measurements taken at various points in the system. This article, Part 3 of a 3-part series, discusses how to use DSAs to develop and model a control system.—*Steve Ashbjornsen and Owen Brown, Hewlett-Packard Co*

Continued on page 7

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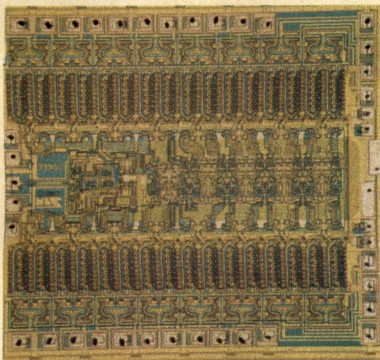


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High-voltage plasma- and EL-display driver ICs can constitute 25 to 40% of a display system's cost, but the chips' prices are dropping rapidly as manufacturers improve their design technologies (pg 57).



Instruments that employ analog techniques to test the surfaces of Winchester disks can, compared with digital testers, reduce test times and increase the probability that faulty tracks will be identified. Furthermore, many testers work with personal computers to provide extensive data-logging capability (pg 71).

TECHNOLOGY UPDATE

Process techniques promise price cuts for plasma- and EL-display drivers

57

Although flat-panel plasma and electroluminescent (EL) displays offer significant size and weight advantages over conventional CRTs, the cost of these displays—significantly influenced by today's driver technology—has kept them from posing a serious challenge to CRTs. Prices are dropping in the display-driver market, however.—*J D Mosley, Texas Editor*

Analog testing and PC hosts boost the capabilities of Winchester disk testers

71

Employing such techniques as analog testing and PC hosting, the latest Winchester disk-drive testers offer improved test times and better performance than did earlier models.—*Stephen H Leibson, Southwestern Editor*

PRODUCT UPDATE

IC-type pressure transducers

87

Floppy-disk-drive analyzer

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Plug-in board and software

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IF chip forms audio decibel-level detector

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Adjustable Schmitt trigger uses one IC

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Circuit gates data channel

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Reduce noise in a serial bit stream

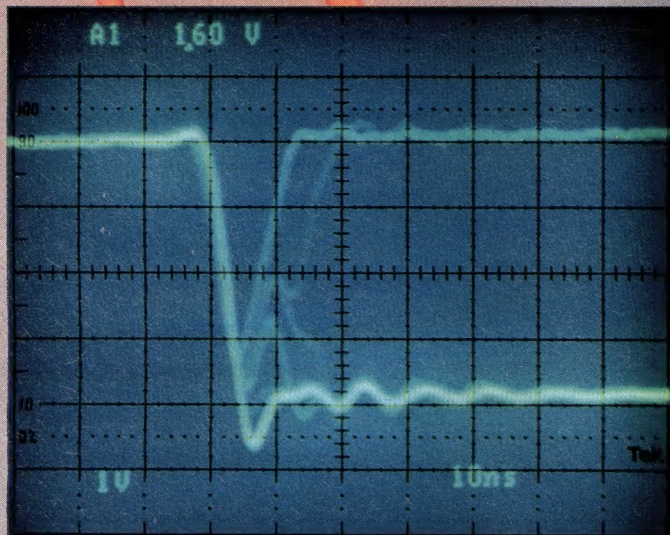
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Program a sine-wave oscillator's frequency

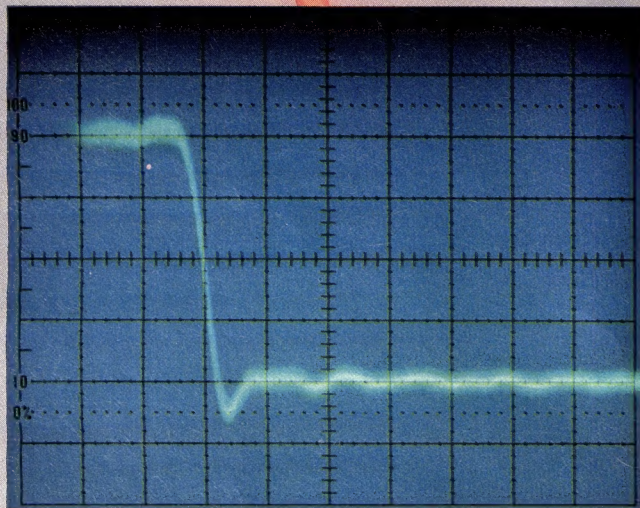
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IN A MATTER OF SECONDS, THE NEW TEK 2467 CAN SAVE WEEKS OF TROUBLESHOOTING.



Now. See what you've always needed to see with a portable scope. (Above) Tek's new 2467 Transient Intensifying Oscilloscope, with its exclusive micro-channel-plate CRT, highlights the infrequent metastability of a flip-flop output. (Below) The same metastability is invisible on a conventional high-speed scope.



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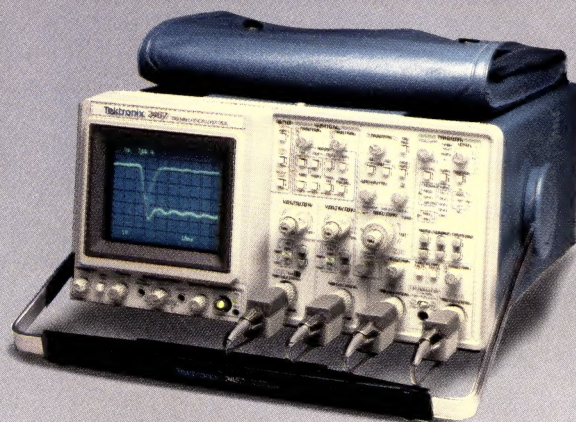
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EDITORIAL

49

Some companies "introduce" products long before you can actually get your hands on them. But, according to 1178 engineers and managers who responded to an EDN poll, there is almost no desire to hear about a product unless it's real or "in sight"—available for purchase within the very near future.

NEW PRODUCTS

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LOOKING AHEAD

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Integrated-software market to peak in 1988 . . . Market for F-O test systems to be worth \$500M by 1994.

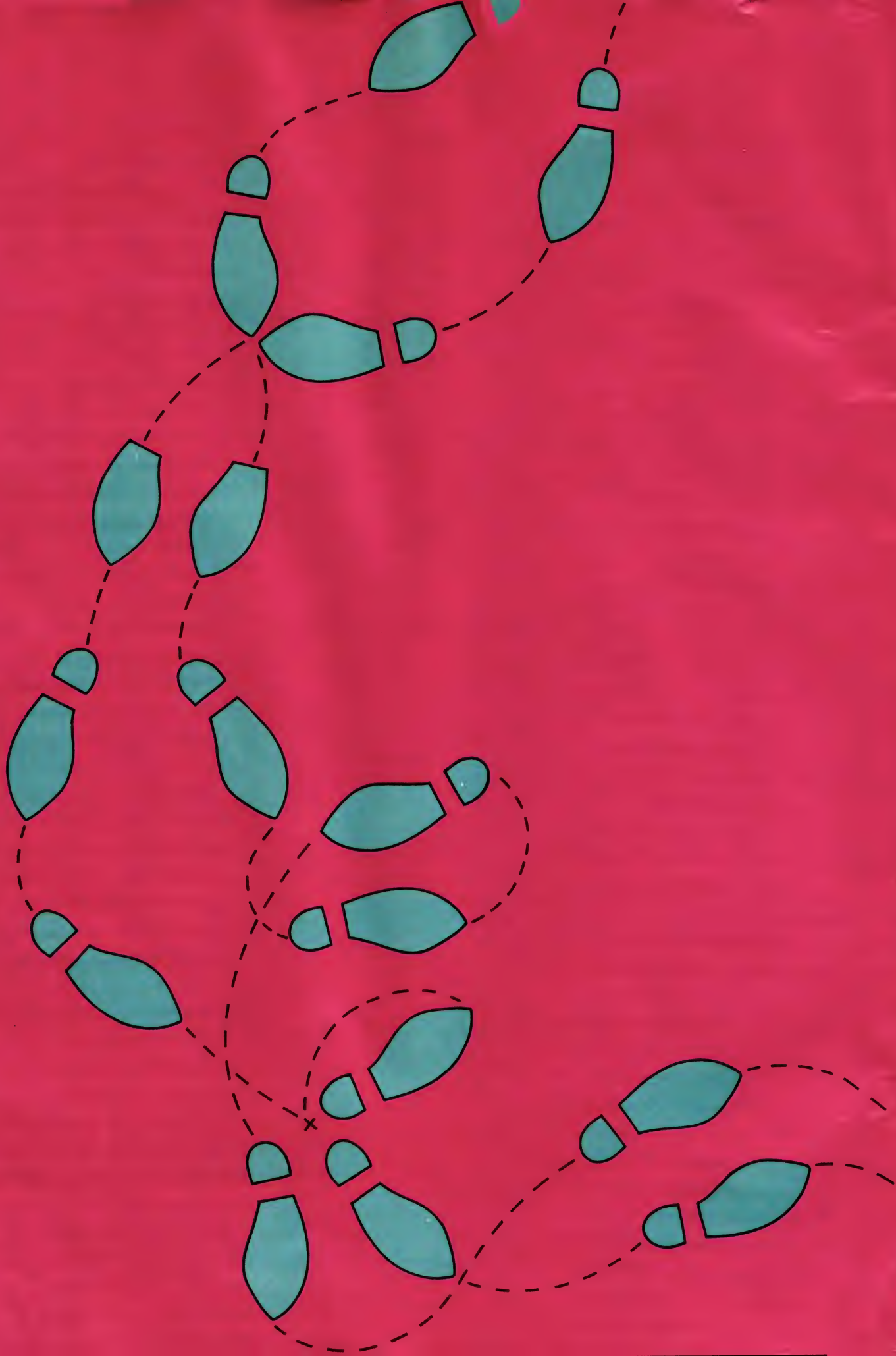
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Transputers are high performance microprocessors optimized for high level language use, and incorporate special features for multitasking and multiprocessor support. The IMS T414—the first in the family—is a 32-bit machine, integrating a high performance processor, 2 kilobytes of fast RAM, four full-duplex interprocessor communications links (with an eight channel DMA engine to service them), and a 32-bit memory interface which includes a DRAM controller: all on a single CMOS chip, dissipating under a watt. And the best part—it's available now.

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JANTXV 2N6764	100V/38.0A	NOW
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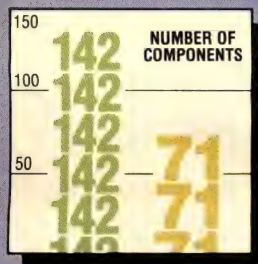
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CIRCLE NO 59

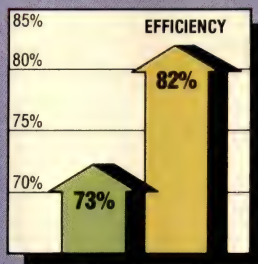
WHAT'S THE DIFFERENCE BETWEEN 1976 AND 1986?

This...



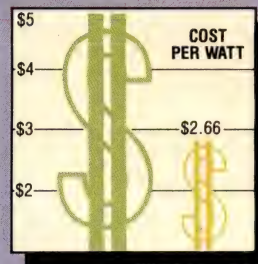
1976 RMD 50 Watts
1986 ERD 60 Watts

and this...



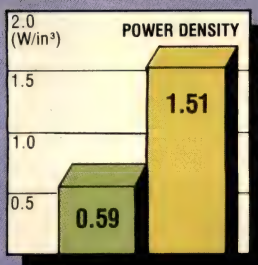
1976 RMD 50 Watts
1986 ERD 60 Watts

and this...



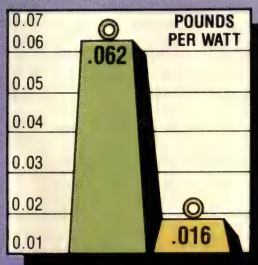
1976 RMD 50 Watts
1986 ERD 60 Watts

and this...



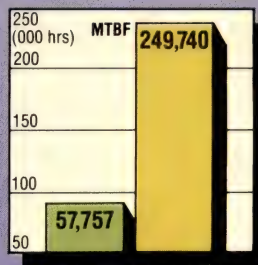
1976 RMD 50 Watts
1986 ERD 60 Watts

and this...



1976 RMD 50 Watts
1986 ERD 60 Watts

and this...



1976 RMD 50 Watts
1986 ERD 60 Watts

Presenting the new d-c to d-c converters Kepco/TDK Series ERD

Actually, the *basic* difference between our new Series ERD and our very popular 10-year-old Series RMD, is 275KHz.

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We're offering Series ERD d-c to d-c converters in three sizes: 30 Watts, 60 Watts, and 150 Watts; 10 models are available in each size: 5V-, 12V-, 15V-, 24V-, and 48V-output.

These d-c to d-c converters are offered with either 24V inputs, or with 48V inputs — 30 models in all.

Single unit prices: 30 Watts, \$135; 60 Watts, \$160; 150 Watts, \$225.

OEM quantity discounts available. Deliveries will begin in May 1986. For complete specifications and 144-page Kepco Applications Handbook and Full Line Catalog, call or write Dept. JGF-12, KEPSCO, INC., 131-38 Sanford Avenue, Flushing, NY 11352 USA • (718) 461-7000 TWX #710 582 2631 • FAX (718) 767-1102.

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33kHz 12-BIT DSP A/D's

MN6227/MN6228

12-Bit Sampling A/D's

Sampling Rate: 33kHz Minimum

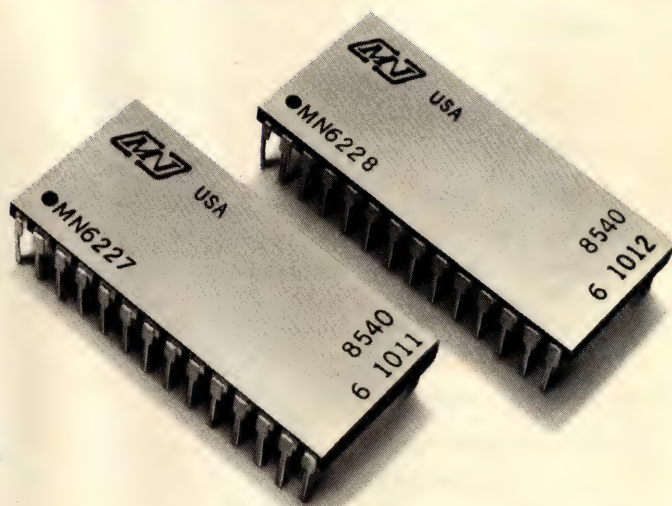
Input Bandwidth: 16.5kHz Minimum

Testing: Frequency Domain (FFT)

Signal-to-Noise Ratio: 70dB Minimum

Harmonics: -80dB Minimum

Price: \$74/100's

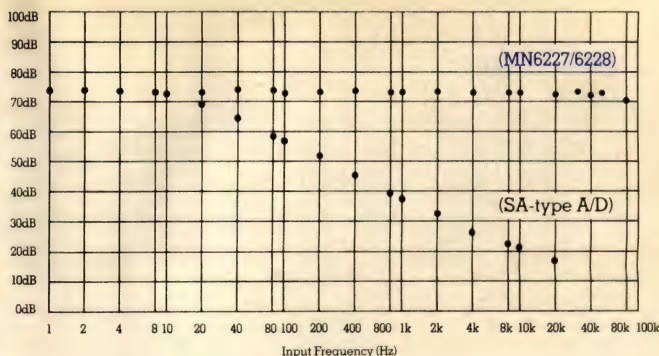
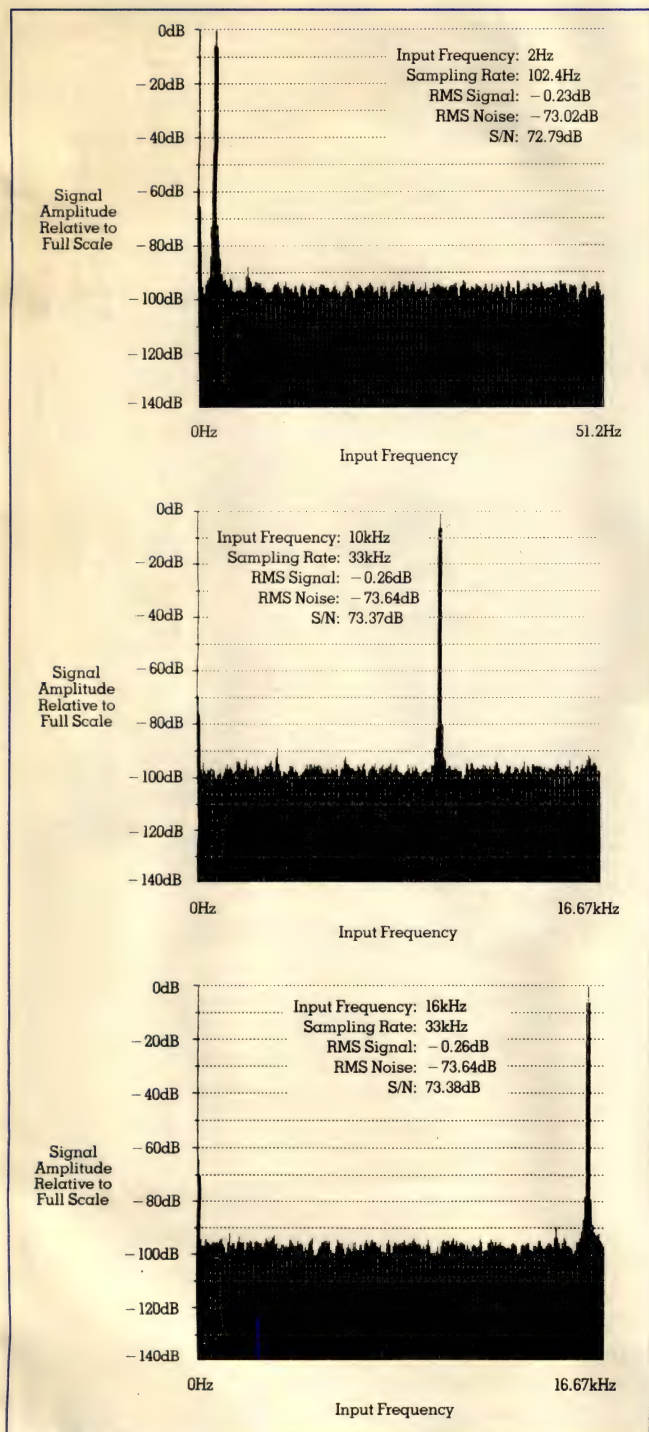


You are looking at the *first* commercially-available, *FFT-tested*, high-speed, 12-bit, sampling A/D converters *specified* for digital-signal-processing applications. MN6227 and MN6228 are 33kHz A/D's with internal track-and-hold amplifiers. They are ideally suited for radar, sonar, spectrum and vibration analysis, voice and signature recognition, and other contemporary DSP applications. Unlike traditional successive-approximation A/D's without track-hold amplifiers,

these true sampling A/D's maintain near-ideal signal-to-noise ratios independent of increasing analog input frequencies. They are *made* for the frequency domain.

Note the FFT spectra (right) and the data plot (top right). They clearly demonstrate the ability of these devices to maintain SNR with increasing input frequencies. In our frequency-domain testing, these devices operate in a manner that simulates a

digital spectrum analyzer with a known low-distortion input signal. The output spectra yield precise, practical measurements of signal level, noise level, signal-to-noise ratio, harmonic distortion, and input bandwidth... the keys to specifying for DSP applications.

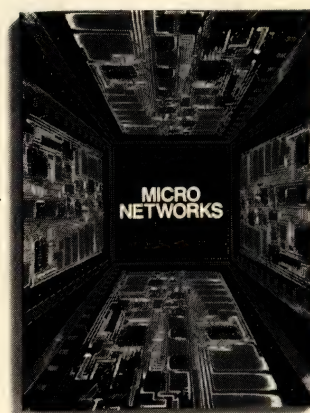


This plot of actual recorded data demonstrates MN6227/6228's ability to maintain near-ideal SNR with increasing input-signal frequency, while A/D's without companion track-holds show rapid (6dB/octave) SNR degradation.

MN6227/6228 are the first A/D's in our new MN6000 series. The 12 and 16-bit converters in this series all contain internal, user-transparent, track-hold amplifiers that enable each device to accurately sample and digitize each dynamically changing input signals with frequency components up to the Nyquist frequency (one-half the sampling rate).

MN6227/6228 have a full 8 or 16-bit μ P interface and are packaged in small, low-profile, 28-pin ceramic DIP's, with the industry-standard MN574A pinout.

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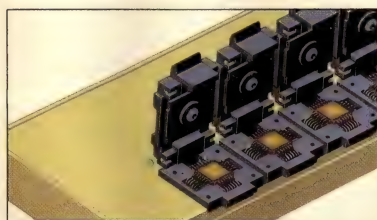
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Plug-in modules will handle leadless devices.

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PP41 All of the PP40's advantages, but useable too for development purposes thanks to its built-in RAM, a powerful editor and dual RS232C I/O ports.

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NEWS BREAKS

EDITED BY JOAN MORROW

PC GRAPHIC-DISPLAY SUBSYSTEM SUPPORTS 1M-PIXEL DISPLAYS

The Viking 1 from Moniterm Corp (Minnetonka, MN, (612) 935-4151) is a high-resolution graphic-display subsystem for IBM and compatible PCs. The \$2195 subsystem includes a 19-in. monochrome monitor, a 2k×1k-bit display memory, and a graphic-controller expansion board based on the Hitachi 63484 advanced CRT controller. The Viking 1's native mode accepts and digitizes video signals from an IBM color graphics or monochrome display adapter, or a Hercules monochrome graphics card. It displays the digitized image in a suitably sized portion of the 1280×960-pixel display for a fully compatible, single-monitor system.—Steven H Leibson

ESDI CONTROLLER PROVIDES VME BUS INTERFACE FOR WINCHESTERS

The V/ESDI 3201 from Interphase Corp (Dallas, TX, (214) 350-9000) lets you add ESDI performance to your VME Bus system. This single-board controller with a multitasking architecture gives you intelligent control for 5½-in. ESDI Winchester disk drives. The board performs disk and bus functions simultaneously by using a virtual buffering scheme for intelligent caching. This scheme reduces the number of disk accesses and results in throughput greater than boards that use unaided 1:1 interleaving. Virtual buffering also eliminates the data overrun and underrun problems associated with FIFO-based controllers. A zero-latency feature reduces the disk-transfer time by one-third. The \$1995 V/ESDI 3201 is software compatible with the company's V/SMD 3200 controller, so you can use the same drivers for either controller.—J D Mosley

LASER TECHNOLOGY REDUCES GATE-ARRAY TURNAROUND TIME

Laserpath Corp (Sunnyvale, CA) offers gate arrays that the company customizes using a laser beam instead of a metallization layer—a technique that reduces turnaround from weeks to days. A wiring network interconnects all transistors on the arrays; the company uses a laser to melt unwanted interconnects, customizing the array for a specific function. Two arrays are currently available: the 880-gate, 66-I/O LP1008L and the 1400-gate, 84-I/O LP1014. For the LP1014, design development costs about \$13,000; manufacture and delivery of five working prototypes costs \$13,500. The company plans a 2200-gate array for July and a 3200-gate version for September. Design support is available for Mentor workstations. GE Semiconductor (Research Triangle Park, NC) markets the arrays and supplies production quantities (customized through metallization patterns).—David Smith

INTERFACE KITS AND SIMULATOR ADD X.21 CAPABILITY TO ANALYZERS

Hewlett-Packard's (Palo Alto, CA) 4951 and 4953A protocol analyzers can now test X.21 systems and equipment with the 18154A and 18178A interface kits, respectively. The 18154A enables the 4953A to monitor, analyze, and simulate traffic between X.21 data-terminal equipment (DTE) and data-communications equipment (DCE) at 64k bps; the 18178A/4951 combination is limited to 19.2k bps. Both interface kits include software and cables for the appropriate analyzer. The 18178A includes an X.21 interface pod and costs \$750. A similar product for the 4951, the \$1150 18197A interface kit, includes the same software and a combination X.21/RS-232-C pod. The 18154A costs \$1250 and needs an additional \$950 18136A RS-449 pod.

Also designed to work with the 4953A, the 18198A X.21 state simulator provides a high-level, state-programming environment for protocol simulation, automatically logs X.21 events, and stores timing information between events. Statements in the 18198A's programming language directly correspond to states in the X.21 protocol. A menu of

NEWS BREAKS

DTE and DCE state simulation programs allows you to concentrate your simulation and analysis efforts on one portion of the X.21 protocol while the 18198A correctly simulates the other states. The 18198A costs \$7000 and includes an X.21 interface pod and simulation software for the 4953A protocol analyzer.—Steven H Leibson

TOKEN-RING DEVELOPMENT TOOLS OFFER PROTOCOL ANALYSIS, TESTING

The TMS380 development tools from Texas Instruments (Houston, TX) help you develop products that are compatible with the IBM token-ring network. The TMS380 lets you establish an operating token ring in less than half an hour and perform protocol analysis and performance testing via PC adapter cards. The copy-all-frames feature allows you to copy every frame of network traffic into a PC for analysis, a helpful feature for the development of upper-level communications protocols. Among the development tools offered are adapter cards for the 8-bit PC bus or 16-bit PC/AT bus, demonstration software, and a wiring concentrator that connects as many as eight PCs. You can add more PCs to the ring by chaining wiring concentrators. Adapter cards and software cost \$1750; the wiring concentrator costs \$1990. The TMS380 development tools support TI's TMS380 token-ring LAN adapter chip set.—J D Mosley

CMOS PC-COMPATIBLE BOARD PLUGS INTO PASSIVE BACKPLANE

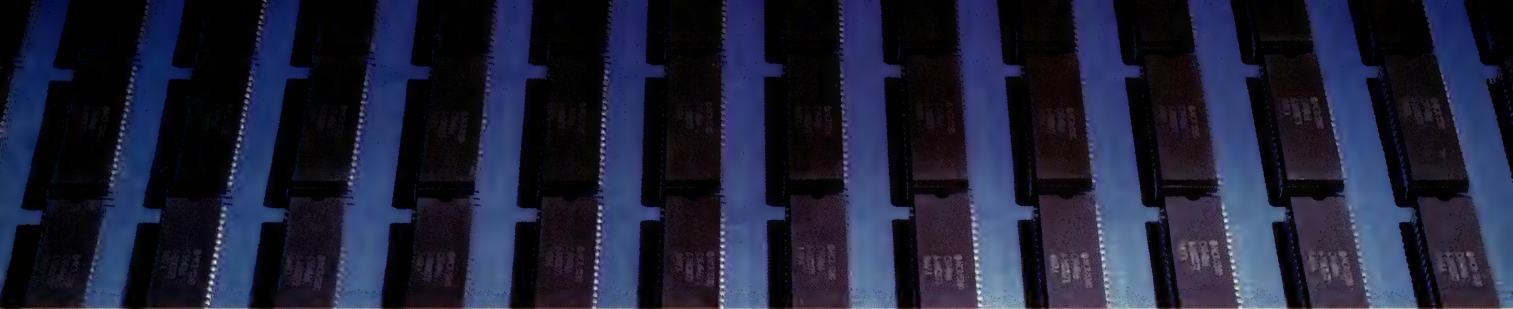
By plugging into a passive backplane, the \$550 CMOS Micro PC from Faraday Electronics (Sunnyvale, CA) reduces the size of PC-based industrial systems and offers the low power consumption of CMOS technology. The board draws 150 mA from the backplane, compared to 450 mA for the manufacturer's NMOS PC cards. The CMOS Micro PC combines an 8088, a socket for an 8087, 256k bytes of RAM, a BIOS, and a keyboard port onto a 4.2x6.2-in. board that matches the form factor for standard IBM PC expansion cards.—David Smith

NONVOLATILE MEMORY CARTRIDGE CUSTOMIZES μ P SYSTEMS

The DS1217M from Dallas Semiconductor (Dallas, TX, 450-0431) gives you a simple way to plug custom applications into your general-purpose μ P-based computer system. The 1M-bit nonvolatile read/write memory cartridge is about the size of a credit card. As long as your computer system contains JEDEC 28-pin byte-wide memory sites, you can retrofit the DS1217M cartridge to your computer via a ribbon cable that is terminated with a 28-pin DIP plug. This static-RAM cartridge can read or write 8 bits of data in 250 nsec, meeting the expectations raised by bubble memories, but surpassing bubble memory in performance and interface simplicity. You can stack as many as 64 cartridges on a common bus for additional storage capacity. The cartridges sell for \$357.50 (100).—J D Mosley

64-BIT FLOATING-POINT PROCESSORS SPEC 40M FLOPS

The 2264 and 2265 floating-point chip set from Weitek Corp (Sunnyvale, CA) can perform as many as 40 million floating-point operations per second (flops) for single-precision arithmetic. They perform double-precision arithmetic at rates as high as 24M flops and 64-bit multiplications at 10M flops. The processors can run microcode written for the company's 1264 and 1265 processors with which the 2264 and 2265 are hardware compatible. The chips conform to the IEEE 754, v.10 standard for floating-point operations. Sample quantities (100) of the set will be available in June for \$700; production quantities will be available in July.—David Smith



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NEWS BREAKS: INTERNATIONAL

EDITED BY JOAN MORROW

FOUR 16-BIT μ Cs USE 80286 AND 80186 μ Ps

Four microcomputers from Fujitsu Ltd use Intel's 80286 and 80186 microprocessors, feature 1M bytes of main memory, and include enhanced networking functions. The FM 16Beta FDII and FM 16Beta HDII, which incorporate the 80286, cost ¥380,000 (\$2111) and \$3640, respectively. The 80186 machines, the FDI and the HDI, cost \$1833 and \$3360, respectively. Fujitsu has adopted CP/M-86 and MS-DOS version 3.1 (that supports communications functions) as the operating systems. The company will later offer Unix and kanji models.

THREE COMPUTERS ARE PC/AT COMPATIBLE

Mitsui Corp has entered the IBM PC/AT-compatible computer market with the CP Series, which includes a portable machine that features a 640×640-dot plasma display. The company is offering the computers to domestic and overseas OEMs. Although Mitsui has not yet announced pricing, it plans to produce 20,000 units during the first year of production.

The CP Desktop incorporates an 8-MHz 80286 processor, 640k bytes of memory, a 1.2M-byte floppy-disk drive, and a 20M-byte hard-disk drive. Samples are available now. The floor model, the CP Cache, has a 10-MHz 80286, 512k bytes of cache memory, 1M byte of main memory, a 1.2M-byte floppy-disk drive, a 40M-byte hard-disk drive, and a 20M-byte cassette streamer. The CP Portable features 512k bytes of standard memory, a 1.2M-byte floppy-disk drive, and a 20M-byte hard-disk drive.

MARUBENI TO BE SOLE DISTRIBUTOR FOR SUPPORT TECHNOLOGIES' ATE

Marubeni Denshi Engineering Co Ltd and Support Technologies Inc (Portland, OR) have signed an agreement that designates Marubeni as Support Technologies' sole distributor of the 3000 Series. This line of portable, automated test equipment is designed for functional test and fault isolation of complex microprocessor-based systems. Along with sales and marketing of the 3000 Series in Japan, Marubeni will provide full customer services such as installation, warranty repair, service, and application support for Support Technologies' products.

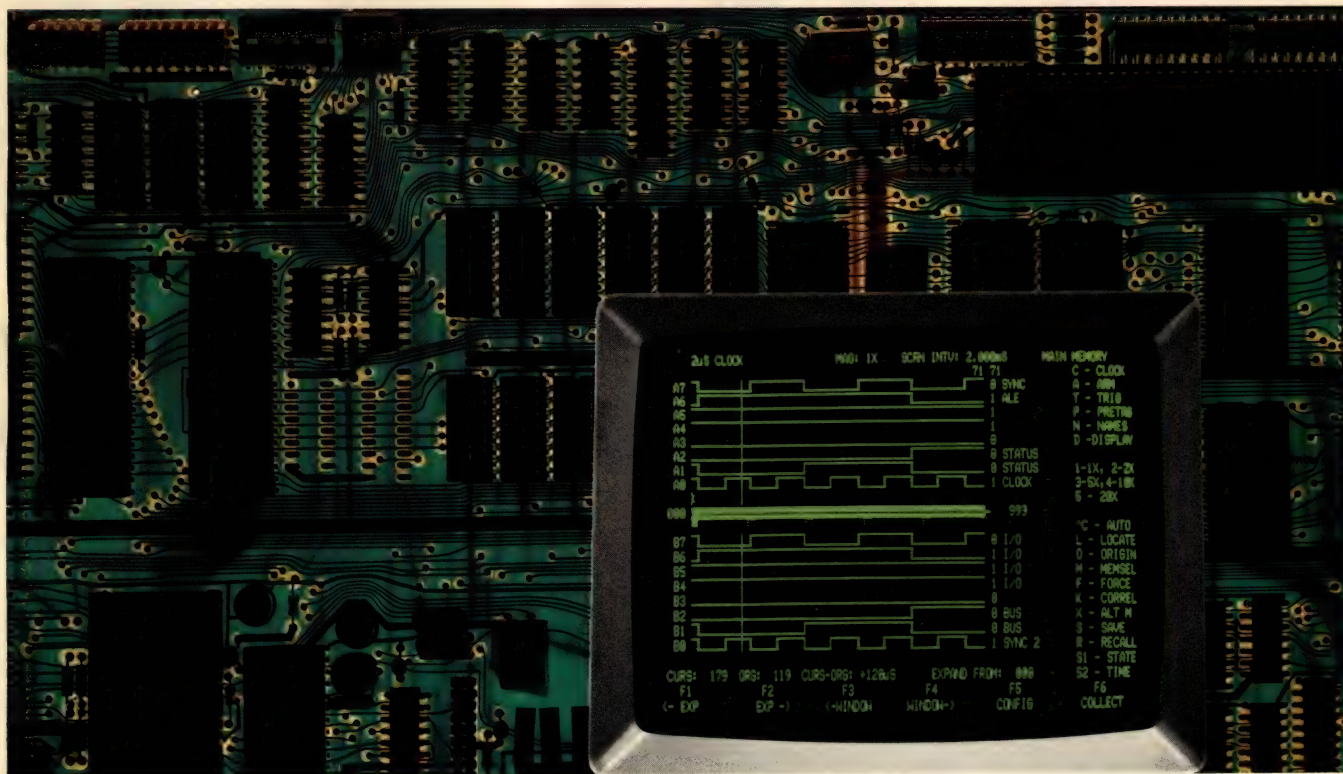
NEC AND FUJITSU ENTER 1M-BIT EPROM MARKET

Nippon Electric Co and Fujitsu have become the first two Japanese companies to develop 1M-bit EPROMs. Samples of the CMOS devices should be available now. Both companies are making the memories in three access times — 150, 200, and 250 nsec. Devices in the MuPD27C1000D Series from NEC allow the user to write the entire capacity of the memory in 30 sec. Power dissipation is 150 mW max during operation and 500 μ W at standby. Fujitsu's MBM27C1000 completes a 1M-bit write operation in approximately four minutes. Power dissipation is 160 mW during operation and 550 μ W at standby.

IMAGE-PROCESSOR CHIP PERFORMS IN REAL TIME

The Risp (real-time image signal processor) from Matsushita Electric Industrial Co features an instruction execution time of 20 nsec. The single-chip device was fabricated under the company's vertically isolated self-aligned transistor technology. The bipolar chip integrates 45,000 elements, including four arithmetic chips and RAMs. Designed for robotics and image-input devices for computer tomographics and office-automation systems, the device can perform 50 million computations per second. Initial price for the processor is approximately ¥200,000 to ¥500,000 (\$1111 to \$2778).

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2000-2500 MHz	2.7 dB max.
ISOLATION	
10-500 MHz	40 dB min.
500-1000 MHz	30 dB min.
1000-2000 MHz	25 dB min.
2000-2500 MHz	20 dB min.
SWR	1.5 max. ("on" state)
SWITCHING SPEED	1 μ sec. (max.)
MAXIMUM RF INPUT	+20 dBm
CONTROL	+5 V (5 mA max.)
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STORAGE TEMPERATURE	-54°C to +100°C

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with the low-cost, MC34080 JFET op amp family.

Rise and shine, adjust your attitude, hold on to your hat. We have liftoff on an innovative new standard in low-cost JFET op amps that will change the way you work, think and design.

Because this practical, no-compromise, 8 MHz family doubles performance directly, immediately, on a pin-for-pin, socket-for-socket replacement basis over older, popular types. Without redesign, rework or rethink.

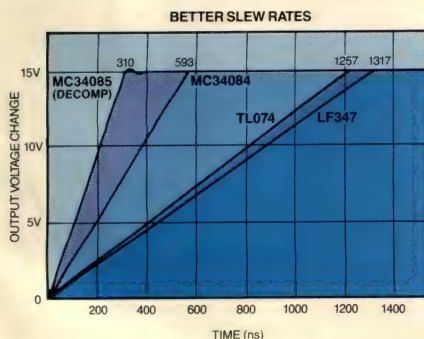
With a unique, all-NPN output stage, the MC34080 series is not only twice as fast as PNP-output also-rans, it also provides a benchmark in output voltage swing.

Start with a 25 V/ μ sec slew rate.

The compensated MC34084 quad slews 15 volts in less than 600 ns.

More than twice as fast as the TL074, it typifies the kind of gain bandwidth product and slew rate you need for high-speed applications.

Take active filters where most bandwidth-limited op amps fail miserably. Higher MC34080 family slew rate and bandwidth means what you get in your final design is really what you designed for--accuracy and efficiency. Put it on a scope trace with any other JFET quad in its category and you'll get comparative dynamics like this:

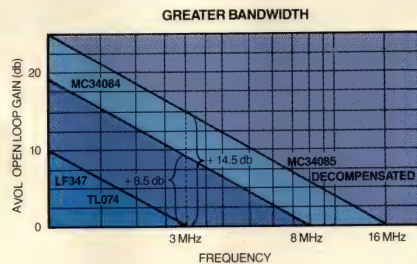


The decompensated MC34085 quad is four times faster than others. Two complete families of compensated and decompensated JFET op amps are available with the singles and duals offering the same 2-to-1 (for compensated) or 4-to-1 (for decompensated) advantage in speed and bandwidth.

What's more, they require only 2.5 mA drain current per amplifier...a significant, no-compromise spec since run-of-the-mill types with less than half the speed require nearly equal current.

More gain, no pain.

In a comprehensive, open-loop Bode-plot analysis, the MC34080 series demonstrates more than twice the gain and bandwidth of competitive LF- and TL- types.



This means your closed loop performance is closer to ideal. Plus, the all-NPN output gives you symmetrical gain and phase margins while sourcing or sinking current into capacitive loads--a nightmare for others.

Now, your system stability is no longer a function of the output voltage swing.

Used in control systems, the MC34080 family follows, tracks and responds to higher-frequency signals quickly, accurately and honestly.

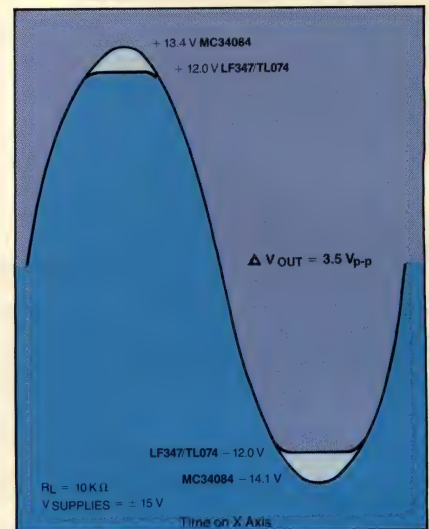
Highest guaranteed output swing.

This advanced family provides minimum guaranteed peak-to-peak output swing into a 2 K load that's 33% greater than others at room temperature.

Spec'd minimum V_{out} of the MC34084 is 3.5 V_{pp} more than that of the LF347 or TL074.

The new-generation, all-NPN output stage also furnishes low open loop output impedance at higher frequencies for improved system performance. Internal trimming cuts input offset voltage to within 0.5 mV maximum for the single and 1 mV for the dual.

GUARANTEED OUTPUT VOLTAGE SWING



One giant leap, one small price.

Hundred-ups for these pace-setting, JFET op amps leave nothing to be desired: the MC34081P single is just 53¢; the MC34082P dual is 85¢ and the MC34084P quad is just \$1.20. Two temperature ranges and four package styles are available.

One-on-one design-in help.

Anywhere in the U.S. or Canada, call for an engineer-to-engineer update on the latest in Motorola op amp technology.

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Call toll-free weekdays, 8:00 to 4:30 p.m., M.S.T. If the call can't

cover it, we'll have an applications engineer contact you. And help you to market faster.

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To: Motorola Semiconductor Products, Inc. P.O. Box 20912, Phoenix, AZ 85036

Please send me the latest Motorola information on the MC34080 including a competitive comparison.

262EDN050186

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NO ONE LIKES



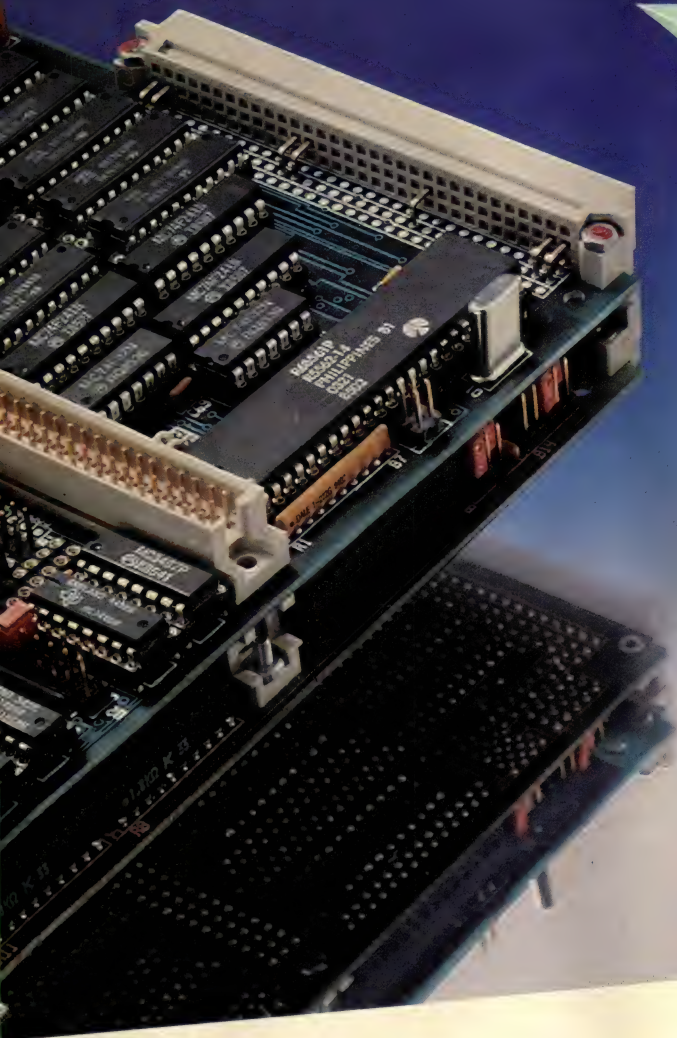
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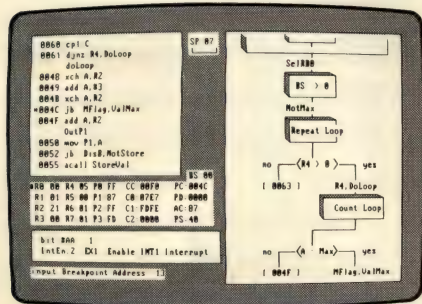
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8049	✓	✓	✓
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8085	✓	✓	
320	✓	✓	
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CIRCLE NO 34

SIGNALS & NOISE

General management courses can aid technical managers

Dear Editor:

Deborah Asbrand's recent article "Graduate programs in technical management help engineers direct technology's future" (EDN, December 26, 1985, pg 171) makes an excellent case for more formalized education for engineering managers. I am not convinced, however, that engineering-management programs should be specifically geared to the technical manager.

I hold an undergraduate engineering degree, and I earned a traditional MBA a few years ago at Pepperdine. The educational experience was challenging, rewarding, and very pertinent to technical management. The opportunity to learn from management situations in non-technical businesses was a particularly broadening experience. Specialized technical management programs might give engineers and scientists a narrow perspective, instead of broadening their management skills.

Technical managers face unique and challenging problems, but so do managers in banking, manufacturing, fashion, and many other industries. Managers in industries other than engineering obtain the management skills and broad perspective they need from traditional MBA programs. Applying these skills to a particular industry or situation is a challenge the manager must always face.

Thank you for the informative and thought-provoking article.

Sincerely yours,
Paul Rudewicz
Product Manager
Kaiser Electroprecision
Irvine, CA

Universal active filter replaces external capacitors

Dear Editor:

In EDN's January 9 issue, Sweden's

Prabhas Gangopadhyay offers a simply marvelous switched-capacitor filter that features separate adjustments for f_0 and Q (Design Ideas, pg 214). One of the external capacitors that the circuit requires has an easy-to-obtain value of 2.9932 nF. Surely every five-and-dime store carries this value.

In case it is news, a few American manufacturers have, for a few years, offered a digitally programmable universal active filter that has separate controls for f_0 and Q . No external capacitors are required save those necessary for adequate bypassing of the power supplies.

Sincerely yours,
Irwin Feerst PE
Massapequa Park, NY

Ed Note: Mr Gangopadhyay's circuit has merit, in our opinion, because you can assemble it quickly, using parts found in most electronics labs. The universal active filters Mr Feerst mentions are also effective, but an engineer might have to wait weeks to get one; five-and-dime stores don't carry them.

As for the 2.9932-nF capacitor, we should have been more explicit. You must add a small variable capacitor to realize this value.

Correction

In the February 20 issue of EDN, the phone number for Fox Research on pg 272 is incorrect. The correct number is (513) 433-2238.

YOUR TURN

EDN's Signals and Noise column provides a forum for readers to express their opinions on issues raised in the magazine's articles or on any topic that affects the engineering industry. Send your letters to the Signals and Noise Editor, 275 Washington St, Newton, MA 02158. We welcome all comments, pro or con. All letters must be signed, but we will withhold your name upon request. We reserve the right to edit letters for space and clarity.

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Sprague Electric Company, a Penn Central unit. Thick-Film Products Division, Nashua, NH. World Headquarters, Lexington, MA.



CIRCLE NO 35

Tektronix

1241 LOGIC ANALYZER

Timing diagram showing digital signals for various components. The signals are labeled on the left: STAT03, STAT02, STAT01, STAT00, PA103, PA102, PA101, PA100, NP000, NP001, NP002, and NP003. The signals are represented by yellow waveforms on a black background. A red vertical line indicates the cursor position at 001 0110 0 4. The top of the diagram shows the page number (PAGE: 0) and the expansion status (EXPAND: +10 +2).

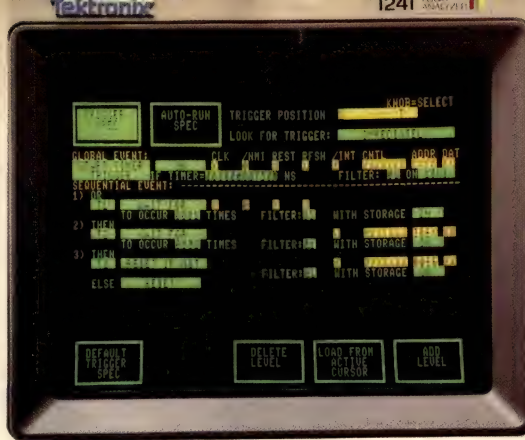
Meet the new 1241—one more reason why Tek's versatile 1200 Series offers you the best of the leading logic analyzers:

1 The 1241's color interface quickly guides your eye to the most relevant information. Analysis is faster. Easier on the eyes. You are more accurate, more productive. For extra readability, a vertical expansion feature doubles the height of the timing diagrams.

2 Like all members of the 1200 Series, the 1241 clearly



shows what your hardware and software are doing at the same time. For integrating partitioned designs, only the 1200 Series' Dual Timebase feature accurately depicts real-time interactions between independently-clocked modules. This lets you monitor relationships between two processors, or between hardware and software. Combine Dual Timebase with performance analysis on the 1241 to analyze the entire system and software performance. Monitor,



for example, the range of time spent by one processor waiting for a service request response from a second processor. The 1241's histogram display and 10ns resolution make these measurements clear and precise.

3 For both hardware and software analysis, Tek offers unsurpassed triggering.

Software problems are pinpointed by 14 levels of conditional triggering combined with data and program flow qualification. Triggering on the timing characteristics, as well as the state of the hardware activity, is made possible by counters, timers, and duration filters.

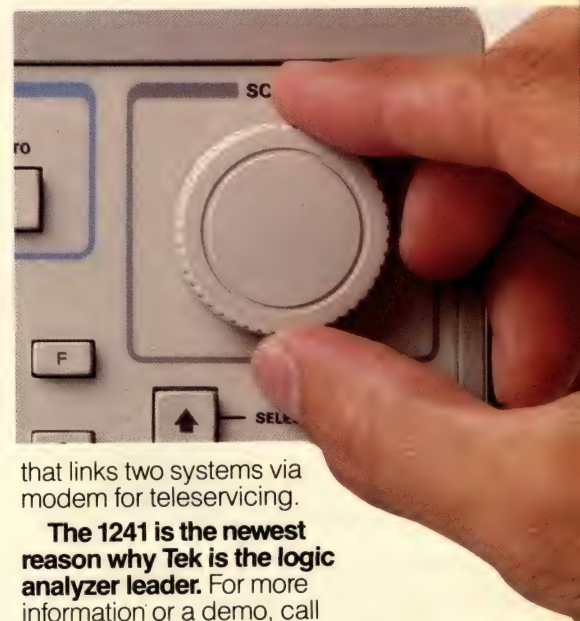
4 Ease of use extends beyond the color screen.

Four distinct levels of operation add features as your design challenges require. A unique touch-screen menu display lets you select over 50 high-level commands right off the screen. The big front panel knob provides flicker-free scrolling.

5 Modular, expandable and versatile, Tek's 1200 Series keeps costs low and compromises few. Support

for all major microprocessors includes three types of dis-assembly. With 14 combinations of 9- or 18-channel acquisition cards, you configure the best data width (up to 72 channels), memory depth

(up to 2K) and sample rate (up to 100 MHz). Add ROM packs for data analysis; RAM packs for storage; COMM packs for RS-232 and GPIB links to computers, plus printer interfacing; and master/slave capability



that links two systems via modem for teleservicing.

The 1241 is the newest reason why Tek is the logic analyzer leader. For more information or a demo, call 1-800-245-2036. In Oregon, call 231-1220. Or contact your local Tek Sales Engineer.



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Outperforms gold.

Du Pont's new BergStik™ II Header with GXT™ Plating.

Pins that outperform gold plus a price that's 10% below the industry standard—you get both in new BergStik II Headers from Du Pont. The key is in the pin coating. Du Pont's exclusive GXT Palladium-Nickel plating protects better than gold to help you keep header performance up, and costs down.

Compare these two platings for porosity, solderability, bend ductility. GXT proves superior to gold in test after test.

Compare them for resistance to wear, to environmental conditions or creep corrosion. Again, GXT clearly outperforms hard gold plating.

Features that mean reliability.

New BergStik II Headers with GXT can help you

achieve the highest standards of reliability. Their drawn-wire pins provide smooth contact surfaces on all four sides. And the sharp corners produced by the drawn-wire process make excellent wire wrapping points providing a gas-tight connection.

Tapered pin lead-ins make for easy insertion into PC boards or female disconnects. Manually-inserted BergStik II Headers give you on-line production capability without capital investment

for machinery.

Selection that meets your needs.

The BergStik II Header line is versatile. Headers can be broken to any length you may desire, reducing



Gold plated pin surface after 25,000 cycles. Note breakdown of hard gold showing undercoat and base metal.



BergStik II pin surface plated with DuPont GXT. Still smooth and unbroken after 25,000 cycles. (Cutaways of pins are microphotographs)



Costs less.♦

inventory requirements on low-volume sizes. Straight and right-angle versions are available with stand-offs at top or bottom for optional insertion. They're stackable, too: side-by-side and end-to-end. (*BergStik II* Headers can also be supplied with gold or tin/lead plating.)

BergStik II comes in single-row configurations with 1 to 36 positions and double-row with 2 through 72 positions. All are available in quantity—immediately—

from Du Pont or from our network of Authorized Distributors.

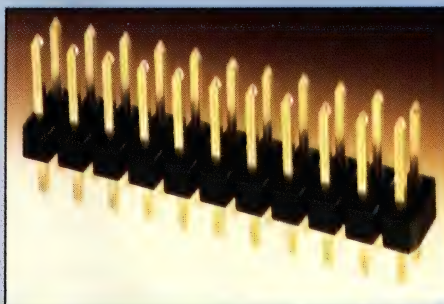
Call us for specials, too. We can provide *BergStik II* with retention features

for robotic assembly. Or with an early ground. Or with various pin lengths. Send us your special requirements.

In *BergStik II*, you buy Du Pont experience (we pioneered headers of this type), delivery speed, depth and breadth of line, and GXT plating superiority—all for 10% less! That's the bottom line. Ask for a quote.

For additional information and samples, call toll-free: 800-237-2374*, or write Du Pont Connector Systems, 30 Hunter Lane, Camp Hill, PA 17011.

**In PA, please call (717) 975-2000.*

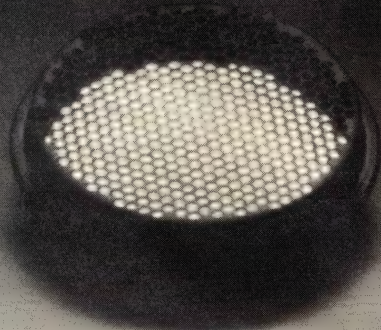


Du Pont *BergStik II* offers you the widest variety of pin lengths and configurations at a 10% savings.

**Berg Electronics is now
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The Polaroid Ultrasonic Ranging System is an accurate, highly sensitive way to detect and measure the presence and distance of objects from 10.8 inches to 35 feet.

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CIRCLE NO 38

CALENDAR

American Consulting Engineers Council (ACEC) Annual Convention, Orlando, FL. ACEC, 1015 15th St NW, Washington, DC 20005. (202) 347-7474. May 11 to 15.

Optical Storage Forum, Denver, CO. Cartlidge & Associates, 1101 S Winchester Blvd, Suite M-259, San Jose, CA 95128. (408) 554-6644. May 12 to 14.

PC Fab Expo, Minneapolis, MN. PC Fab Expo, 1790 Hembree Rd, Alpharetta, GA 30201. (404) 475-1818. May 12 to 14.

Custom Integrated Circuits Conference, Rochester, NY. Roberta Kaspar, CICC, 20 Ledgewood Dr, Rochester, NY 14615. (716) 865-7164. May 12 to 15.

Modern Power Conversion Design Techniques (short course), Parsippany, NJ. E/J Bloom Associates, 115 Duran Dr, San Rafael, CA 94903. (415) 492-8443. May 12 to 16.

Computer Standards Conference, San Francisco, CA. IEEE Computer Society, 1730 Massachusetts Ave NW, Washington, DC 20036. May 13 to 15.

Electro, Boston, MA. Electronic Conventions Management, 8110 Airport Blvd, Los Angeles, CA 90045. (213) 772-2965. May 13 to 15.

Mini/Micro Northeast, Boston, MA. Electronic Conventions Management, 8110 Airport Blvd, Los Angeles, CA 90045. (213) 772-2965. May 13 to 15.

Modern Electronic Packaging, Philadelphia, PA. Technology Seminars, Box 487, Lutherville, MD 21093. (301) 269-4102. May 13 to 15.

Hong Kong Elenex '86, Wanchai, Hong Kong. Eileen Lavine, Information Services, 4733 Bethesda Ave, Bethesda, MD 20814. (301) 656-2942. May 13 to 16.

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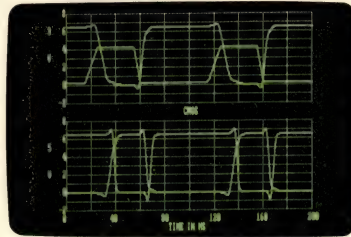
How many long unproductive hours have you spent "in line" for your simulation? Well, no more. MICROCAP and MICROLOGIC can put you on line by turning your PC into a productive and cost-effective engineering workstation.

Both of these sophisticated engineering tools provide you with quick and efficient solutions to your simulation problems. And here's how.

MICROCAP: Your Analog Solution

MICROCAP is an interactive analog circuit drawing and simulation system. It allows you to sketch a circuit diagram right on the CRT screen, then run an AC, DC, or Transient analysis. While providing you with libraries for defined models of bipolar and MOS devices, Opamps, transformers, diodes, and much more, MICROCAP also includes features not even found in SPICE.

MICROCAP II lets you be even more productive. As an advanced version, it employs sparse matrix techniques for faster simulation speed and larger net-

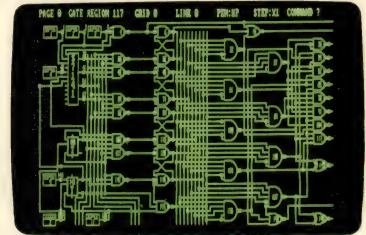


"Typical MICROCAP Transient Analysis"

works. In addition, you get even more advanced device models, worst case capabilities, temperature stepping, Fourier analysis, and macro capability.

MICROLOGIC: Your Digital Solution

MICROLOGIC provides you with a similar interactive drawing and analysis environment for digital work. Using standard PC hardware, you can create logic diagrams of up to 9 pages with each containing up to 200 gates. The system automatically creates the netlist required for a timing simulation and will handle networks of up to 1800 gates. It provides you with libraries for 36 user-defined basic gate types, 36 data channels of 256 bits each, 10 user-defined clock waveforms, and up to 50 macros in each network. MICROLOGIC produces high-resolution timing diagrams showing selected waveforms and associated delays, glitches, and spikes—just like the real thing.



"Typical MICROLOGIC Diagram"

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Regarding MICROCAP... "A highly recommended analog design program" (PC Tech Journal 3/84). "A valuable tool for circuit designers" (Personal Software Magazine 11/83).

Regarding MICROLOGIC... "An efficient design system that does what it is supposed to do at a reasonable price" (Byte 4/84).

MICROCAP and MICROLOGIC are available for the Apple II (64k), IBM PC (128k), and HP-150 computers and priced at \$475 and \$450 respectively. Demo versions are available for \$75.

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Programming in Lisp and Prolog, San Diego, CA. Integrated Computer Systems, Box 45405, Los Angeles, CA 90045. (800) 421-8166; in CA, (800) 352-8251. May 13 to 16.

Miconex '86, Winnipeg, Canada. M Barakat, National Research Council, 307-155 Carlton St, Winnipeg, Manitoba R3C 3H8, Canada. May 14 to 16.

Rocky Mountain Information Expo and Conference, Denver, CO. Industrial Presentations West, 12371 E Cornell Ave, Aurora, CO 80014. (303) 696-6100. May 14 to 16.

Surface-Mount Technology Design Workshop, Cambridge, MA. IPAC, Box 1869, Los Gatos, CA 95031. (408) 354-0700. May 19 to 20.

Structured 8086/186 Assembler (short course), Madison, WI. Micro-Managers, 1435 E Main St, Madison, WI 53703. (608) 251-6661. May 19 to 23.

Marketing Communications for Computer Manufacturers and Software Firms, Waltham, MA. Jason Taylor Associates, 8 Fulton Rd, Lexington, MA 02173. (617) 862-3574. May 20 to 21.

Eastern Telecommunications Showcase, Atlanta, GA. US Telecommunications Suppliers Association, 333 N Michigan Ave, Suite 161B, Chicago, IL 60601. (312) 782-8597. May 20 to 22.

Grounding and Shielding (short course), Minneapolis, MN. Interference Control Technologies, Box D, Gainesville, VA 22065. (703) 347-0030. May 20 to 23.

MIL STD 461/462 and System Level Testing Procedures (short course), Philadelphia, PA. Interference Control Technologies, Box D, Gainesville, VA 22065. (703) 347-0030. May 20 to 23.

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EDN 5/1/86

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CIRCLE NO 41

Molex Is Making The Connection Between...

INNOVATION & AUTOMATION

In an effort to offer interconnection devices with lower installed costs, Molex has developed a packaging system that integrates unique product design with automated wire assembly and robotic placement capabilities.

To attain maximum production efficiencies, we concentrated our resources and technology on three important aspects of innovation and automation.

1. First: A range of single and dual row connector products developed for maximum design flexibility.

One example of this is our .100" x .100" C-Grid product line. C-Grid offers fully stackable components including single piece IDT connectors, shrouded headers, printed circuit board connectors, modular breakaway headers, shunts, clips, and additional options for maximum design flexibility. With C-Grid, discrete wire or cable assemblies can be brought to a common point and can be independently disconnected as needed. This allows you to consolidate your harnesses.

2. Semi and fully automatic wire and cable assembly equipment designed to significantly reduce installed costs.

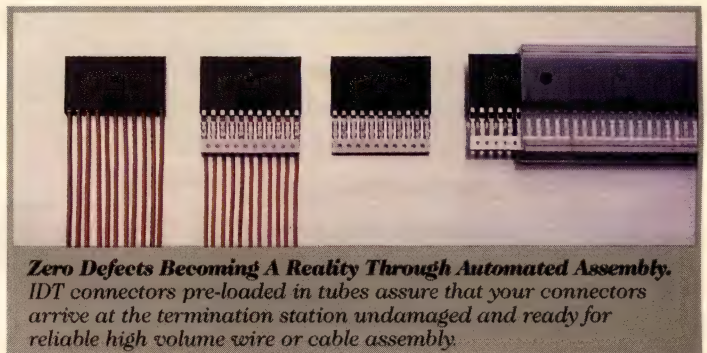
Manufacturing cost savings are realized with our unique packaging and automation equipment. From operator assisted semi-automatic rates (approximately 1,500 terminations per hr.) to high-speed fully-automatic equipment (43,000 terminations per hr.) that tests and verifies the reliability of every termination.

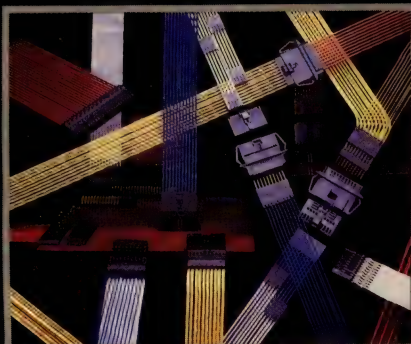
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Molex engineers understand the relationship between products and processes. We've developed delivery systems that can automatically feed Molex components to robotic equipment for rapid placement on printed circuit boards. Whether reel/tape fed, cartridge fed, or box container, our compatible delivery systems work to increase the productivity of your robotic systems.

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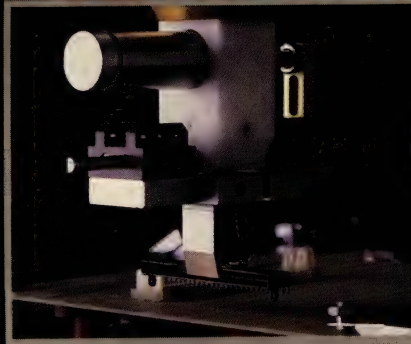




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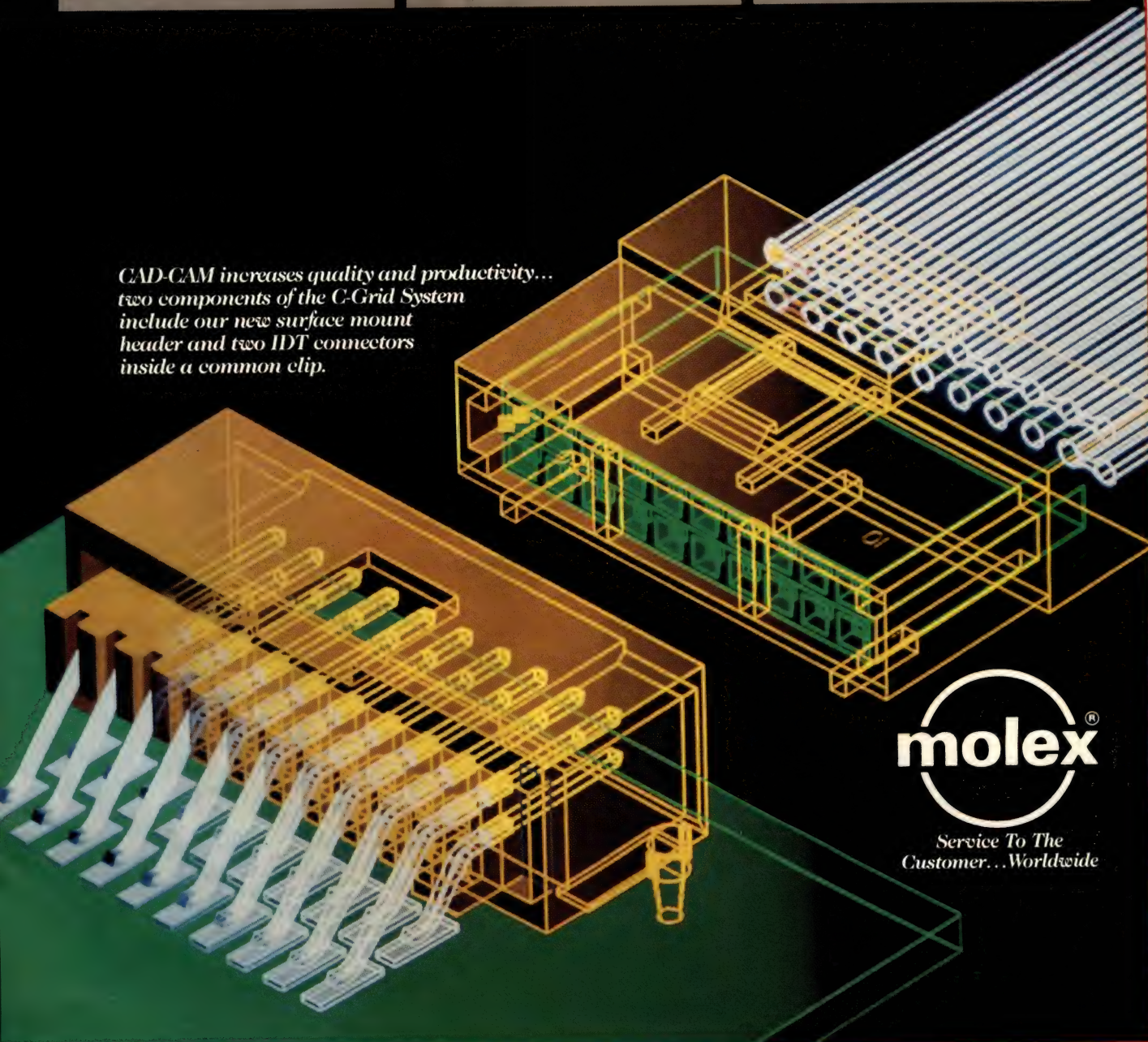


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IMS2800-80		43ns	80ns	146ns
IMS2800-10		53ns	100ns	176ns

Part Number	Function	Column Access Time (Max.)	CAS Access Time (Max.)	Page Mode Cycle Time (Min.)
IMS2801-60*	Enhanced Page Mode	32ns	11ns	35ns
IMS2801-80		43ns	13ns	46ns
IMS2801-10		53ns	16ns	56ns

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Norman L Cahners 1914-1986

Norman L Cahners, founder and honorary chairman of the Cahners Publishing Co, died March 14 after an illness that lasted several months.

Mr Cahners was born in Bangor, ME, in 1914 and was educated at Phillips Academy and Harvard College, where he was on the varsity football and track teams.

Mr Cahners began the Cahners Publishing Co in 1946. His first magazine, *Modern Materials Handling*, was based on the knowledge he had gained as a Navy specialist in cargo-handling operations during World War II.

At the time of his death, his company had grown to be one of the largest business publishing companies in the US with 35 specialized magazines and numerous newsletters, directories, and buyers guides. Mr Cahners was an early proponent of controlled, or qualified, circulation. He was among the earliest publishers to use full-color printing processes in the editorial pages of business magazines.

Mr Cahners's most notable contribution to magazine publishing was his development of the "niche" concept. He believed that each of his magazines had to reach and serve very well-defined groups of readers. This concept enables his company to publish several different magazines in closely related fields.

He played a key role in merging the former National Business Publications and American Business Publications associations into the American Business Press. And in 1984, he received the ABP Scroll, the highest award from the American Business Press. Mr Cahners was also a founding member and first chairman of the International Business Press Associates and served as Chairman of the Business Press Advisory Committee on Civil Rights.

Along with the honorary degrees Mr Cahners received from many universities, he received Harvard Business School's Business Statesman Award, which is given annually to the person whose leadership and achievements are outstanding in both the business world and in the community.

He was chairman of the board of Boston's Museum of Science and a fellow of the American Academy of Arts & Sciences. An avid supporter of higher education, he served as vice chairman, Northeastern University; fellow, Brandeis University; and trustee, Colby College; and he was a member of the Harvard University Overseers Committee on University Resources.

Mr Cahners was also an active supporter of quality medical care and research in Boston hospitals and medical centers, serving as overseer, Children's Hospital and Medical Center; trustee, New England Medical Center; and trustee for life, Beth Israel Hospital. He also served as member of the corporation for both the Massachusetts General Hospital and Boston's Affiliated Hospital Center.





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EDITORIAL

It's unreal!



We've written before on this page (November 14, 1985, and August 9, 1984) about products that companies "introduce" long before you can actually get your hands on them. These products are, quite literally, unreal. Maybe you can buy one eventually, maybe not. Maybe they'll work as described when they finally appear, maybe not. Only one thing is certain: If you try to plug one of them into a design of yours, you'll find your design has a hole in it.

"So what?" the companies say. "Don't engineers and managers want information as early as they can get it? Don't they want to know what we've got coming down the road?"

In a word, no. According to 1178 engineers and managers who responded to an EDN poll, there is almost *no* desire to hear about a product unless it's real or "in sight"—available for purchase within the very near future. Our survey indicates that

- Only 2.6% of engineers and engineering managers want to know about a product more than a year before they can buy it.
- Only 7.4% want information more than six months before product availability.
- Only 21.3% want information more than 90 days before availability.

The message is clear: If you can't buy it *soon*, it's unreal. If you can't put it in your next design, it's science fiction.

Frankly, we see far too much science fiction in the technical press. It often falls under a heading of "Exclusive," indicating that the publication in which it appears is delivering something that no other publication can. The truth is, the publications that adhere to this questionable practice are often delivering something that no other publication wants. Although responsible publications wait until a product is real before writing about it, these few ignore engineers' wishes and write about it long before it exists. Usually, they don't even let their readers know it isn't available. Often, and incorrectly, they imply that it *is* available. Then, after deceiving their readers, they have the audacity to boast of having the most "exclusive, up-to-date" coverage.

Briefly stated (again), EDN's policy is to write about products only when they exist or will be available very soon. Occasionally, we make an exception for a product, such as a 32-bit microprocessor, that requires a long design-in time, but if a product isn't already available, we let you know, according to our best information, when it will be.

We really don't have anything against science fiction, provided it's *good* science fiction. You can find the good stuff in publications such as *Analog* and *Isaac Asimov's Science Fiction Magazine*. Don't look for science fiction in EDN, though. We specialize in nonfiction.

Gary Legg

Gary Legg
Editor

Temperature sensors

Do you have temperatures that you want to detect electronically and further process, like between -55 and +450°C?

Siemens has just the right temperature sensors for this range, NTC thermistors.

And for the more "normal" range of -50 through +150°C there's a choice of two:

NTC thermistors and silicon sensors.

Both convert temperature changes into alterations in resistance that are easy to detect electrically. They're quite different in their technology though and their resistance/temperature characteristics are fully opposed.

But there are still applications where it's difficult to choose one or the other. So it's all the more important to know both sensors and their features plus all the selection criteria produced by conditions of use.

You'll find the major differences between the products below. There's a lot more – about the product line, selection of designs, circuit examples, etc. – in an info package that we'll be glad to send you.

Just write Siemens AG, Infoservice 12/Z 007, Postfach 23 48, D-8510 Fürth, West Germany, quoting "Temperature sensors".

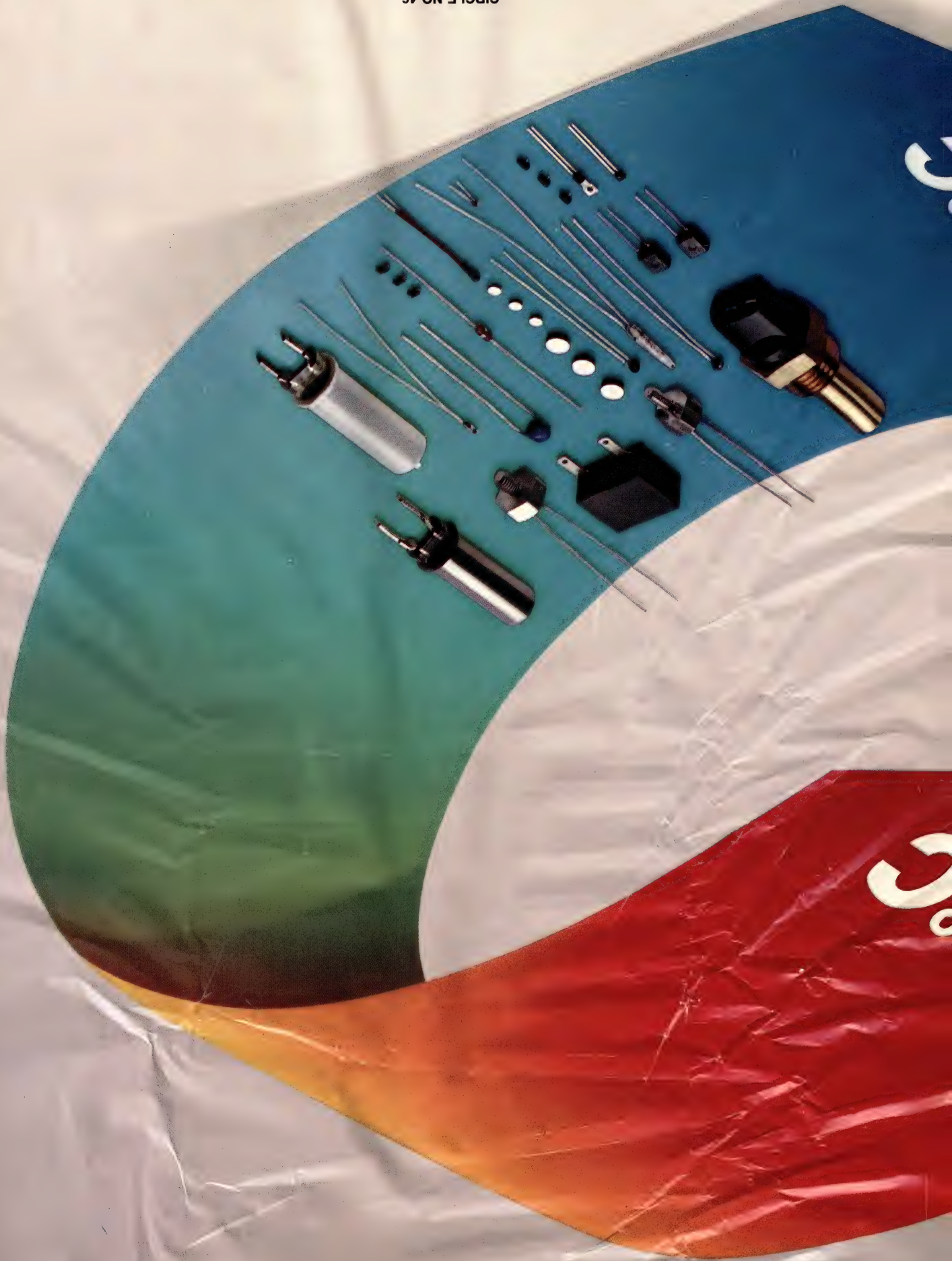
Temperature sensors compared

Criterion	Silicon	NTC thermistor
Temperature coefficient	positive	negative
Linearity	linear	logarithmic
Sensitivity	10 to 80 mV/K	50 to 500 mV/K
Resistance rating (25°C)	2 kohms	1.5 ohms to 1 Mohm
Temperature range	-50 to +150°C	-55 to +450°C
Designs	Sensors come in a wide variety of packages, as SMDs too; and NTC thermistors also as disk types without packaging.	

12/Z 007.101

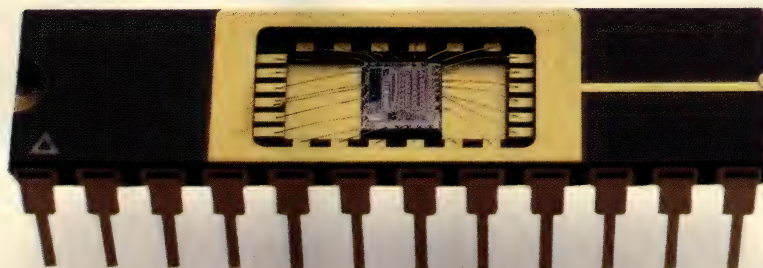
+450

-55



REVOLUTION BY
ANALOGY.





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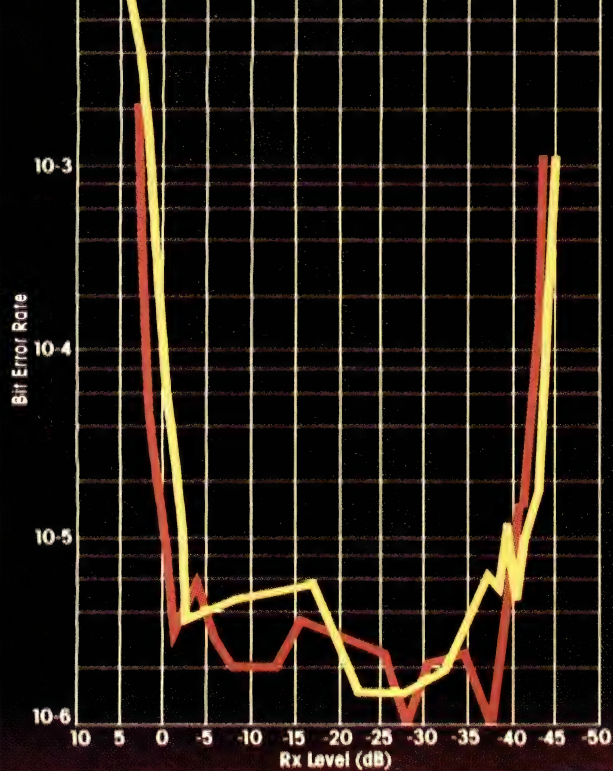
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TECHNOLOGY UPDATE

Process techniques promise price cuts for plasma- and EL-display drivers

J D Mosley, *Texas Editor*

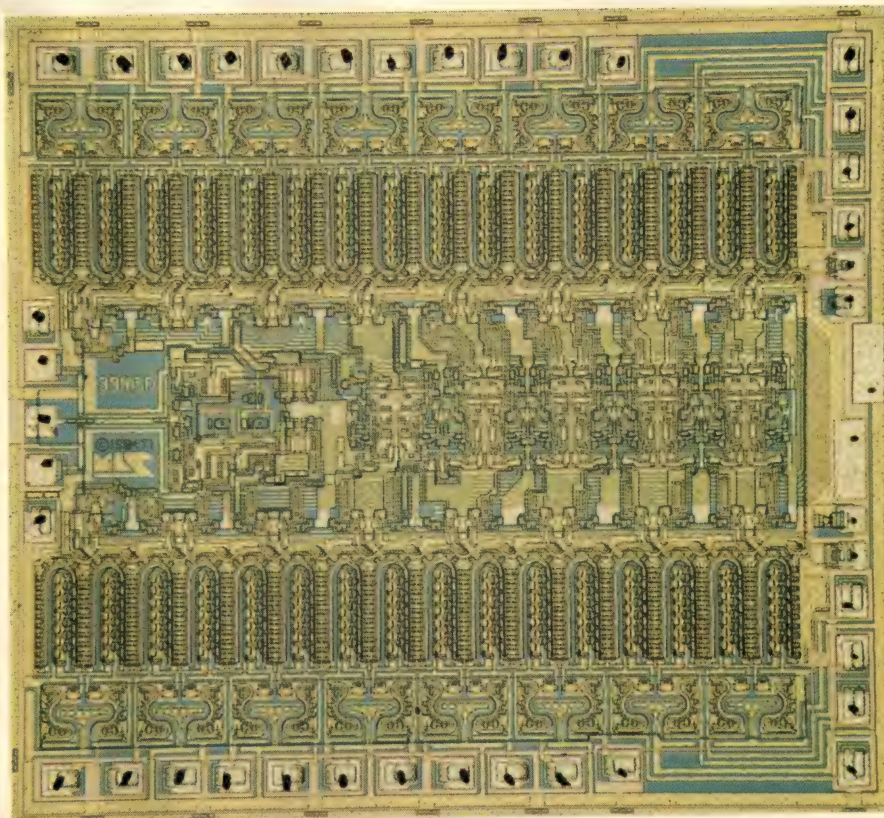
Although flat-panel plasma and electroluminescent (EL) displays offer significant size and weight advantages over conventional CRTs, the cost of these displays—significantly influenced by today's driver technology—has kept them from posing a serious challenge to the firm hold that CRTs now have on the display market. The high-voltage, expensive chips that drive plasma and EL displays constitute 25% to 40% of the total display cost. Prices are dropping rapidly in the display-driver market, however, as manufacturers improve their respective design technologies.

10V input and 200V output

Plasma and EL displays are flat-panel displays that operate at relatively high voltage levels compared with the 5 to 12V logic inputs that drive them. Plasma-display drivers frequently handle 100V outputs, while EL drivers may control output voltages reaching 250V.

These typical voltage ranges are not rigidly applicable, however. As display manufacturers work to reduce the voltage requirements of their products, it's not uncommon to find drivers that were designed for plasma displays now being used to control low-voltage EL screens. And because you can multiplex a few high-voltage drivers to control a display surface that would normally require many lower-voltage drivers, it isn't unheard of to use EL drivers for plasma displays.

Basically, both EL and plasma drivers convert a low-voltage serial-data input into a high-voltage parallel display output (see **box**, "Flat-panel structures and their



This 100V, 32-channel ac plasma display driver from Texas Instruments comes in a 44-pin plastic leaded chip carrier and offers an extended operating range of -40 to 85°C for automotive applications.

operation"). Drivers with 16 or 32 output lines or channels are common, although Supertex has been marketing 64-channel display drivers since 1984. To control large displays, you must multiplex several drivers. For example, a typical 25-line×80-character computer display accommodating 6×8-pixel characters has 480 column channels and 200 row channels; you would need 30 16-output column drivers and 13 16-output row drivers for such a display.

In 1983, only three companies offered high-voltage display drivers: Texas Instruments, Supertex, and Sharp. Today, Siliconix and Sprague offer compatible versions

of many of these drivers, and the more established companies are broadening their product lines. One company, Telmos, offers custom devices for output voltages in the neighborhood of 400V.

Almost every company that now produces plasma and EL drivers bases its products on a different technology from the others. And each seems convinced that its way is the key to successful price competition against the 30-year-old CRT.

Process yields durable parts

Sprague Electric Co developed the BiMOS II method for fabricating high-voltage display drivers from a bipolar process. BiMOS II

combines CMOS low-level input logic, open-drain or totem-pole double-diffused MOS (DMOS) output circuits, and bipolar source drivers. Although the use of bipolar devices gives these driver chips higher current ratings than commonly found in this market, the company views this fact as inconsequential where performance is concerned. As a benefit,

the BiMOS II process offers a built-in measure of safety to prevent chip destruction. All-MOS drivers can self-destruct if you remove the low-voltage power supply from the driver before disconnecting its high-voltage supply; the BiMOS II process yields devices that are less susceptible to such problems.

Sprague's recently introduced

6-MHz EL-display row drivers, the UNC-5851/5852, and 7.5-MHz column drivers, the UNC-5853/5854, serve as alternatives to Texas Instruments' familiar 32-channel SN75551/2/3/4 chip set. The Sprague row drivers have an output voltage rating of 225V and sink as much as 120 mA. The column drivers furnish a 60 or 80V breakdown

Flat-panel structures and their operation

Plasma and electroluminescence aren't your only choices when considering flat-panel displays, but they have distinct advantages. LCDs and LEDs are flat, but these low-voltage displays can't provide the brightness, resolution, contrast, viewing angle, and operating temperature range that high-voltage, active displays offer. Vacuum-fluorescent (VF) displays are also active, flat-panel devices, but they're generally used for small displays. VF display technology is based on triode-tube theory, while EL and ac plasma display technology are based on element capacitance.

In EL displays, the column and row drivers form an X-Y matrix locating each display element. The elements are sandwiched between the row and column output lines to provide a voltage differential across each element. To illuminate an element, you must apply successive, opposite-polarity voltage

pulses that exceed a threshold voltage specified by the display. A power source external to the driver ICs supplies the necessary voltages. The element acts like a capacitor in the driver-output circuit, with the row driver behaving like an open-drain switch and the column driver behaving like a grounded totem-pole switch (**Fig A**).

Assuming a $\pm 200\text{V}$ threshold, you could select a row driver that switches periodically between 200 and -140V , and a column driver that switches between 60V and ground according to input-logic commands. When the row driver toggles to the 200V output, the column driver provides a path across the element to ground. When the row driver toggles to -140V and the column driver remains switched to ground, the element sees -140V and does not light. If, however, the column driver toggles to 60V, this voltage adds to the row driv-

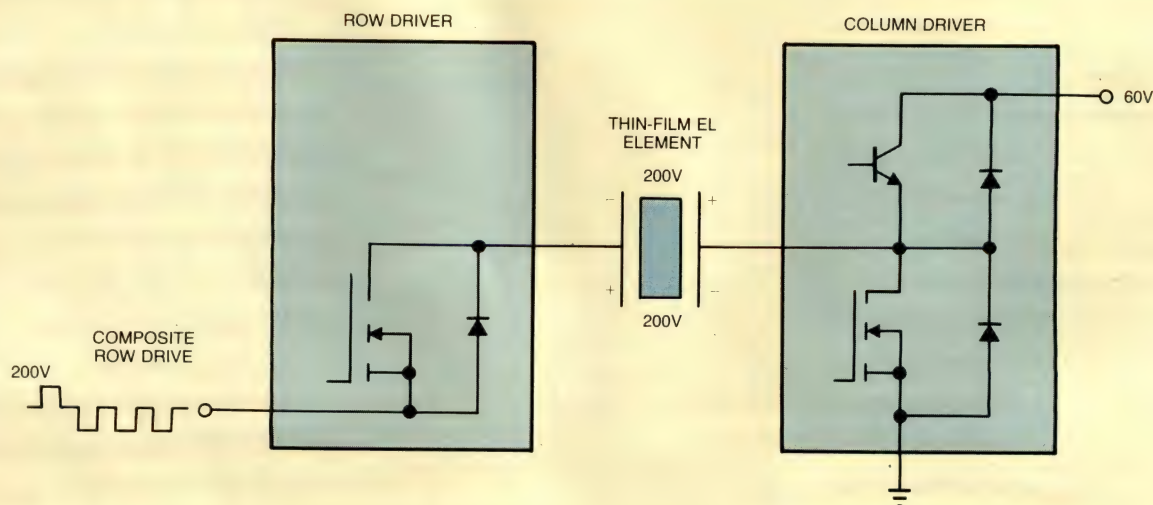


Fig A—The element in this EL driver circuit acts like a capacitor, the row driver behaves like an open-drain switch, and the column driver operates as a grounded totem-pole switch.

TECHNOLOGY UPDATE

voltage and sink or source as much as 25 mA. You can order these chips in 40-pin DIPs with 0.6-in. row spacing, or in plastic 44-lead chip carriers with J-lead bends for surface mounting. They cost \$4.80 in 1000-piece quantities, or \$3.40 in quantities of 100,000.

Texas Instruments also uses bipolar switches in its driver designs,

but unlike Sprague's technique, TI's BIFET process derives from the company's work with CMOS circuitry. BIFET is a high-voltage technology that integrates npn and pnp bipolar, CMOS, DMOS, and JFET transistor devices on the same monolithic substrate.

The CMOS circuitry forms the drivers' LSI input logic, which op-

erates from supply voltages to 18V. DMOS transistor structures allow output voltages as high as 250V and breakdown voltages in excess of 300V. For displays with lower voltage requirements, bipolar npn structures provide outputs to 70V while using about one-fifth of the die area that a DMOS transistor would occupy.

er's -140V and the element receives an illuminating -200V.

Plasma displays come in ac and dc versions. The dc displays are driven rather like CRTs: You use electrons to excite directly the phosphors used in the display screen. In contrast, to drive an ac plasma display, you must develop an X-Y matrix of driver lines similar to the previously discussed EL driver matrix. The row and column drivers in an ac plasma display can be identical chips—totem-pole switches, for example—unlike the distinctly different EL row and column drivers.

The waveforms you must generate to turn on and turn off an ac plasma element are more complex than the simple additive activity that provides EL display logic. Both the row driver and the column driver for an ac plasma display can have the same voltage inputs. The column driver is tied

to ground, while the row-driver input floats on a square wave called a bulk-sustain wave (Fig B).

To illustrate, assume a 90V input on both the row and column drivers, and a 0V to 110V square wave for the bulk-sustain wave. Timing is critical; you must apply a certain sequence of row and column driver pulses, timed in a particular manner, to toggle a display element. The instantaneous sum of the three driver voltages creates the functional waveforms. One waveform will turn elements on, and a different waveform will turn them off.

Once an element is lit, it stays lit until you apply the correct functional waveform that turns it off. This feature and the lower supply voltages required for an ac plasma display reduce the complexity of the display's driver circuitry compared with EL and dc plasma driver circuitry.

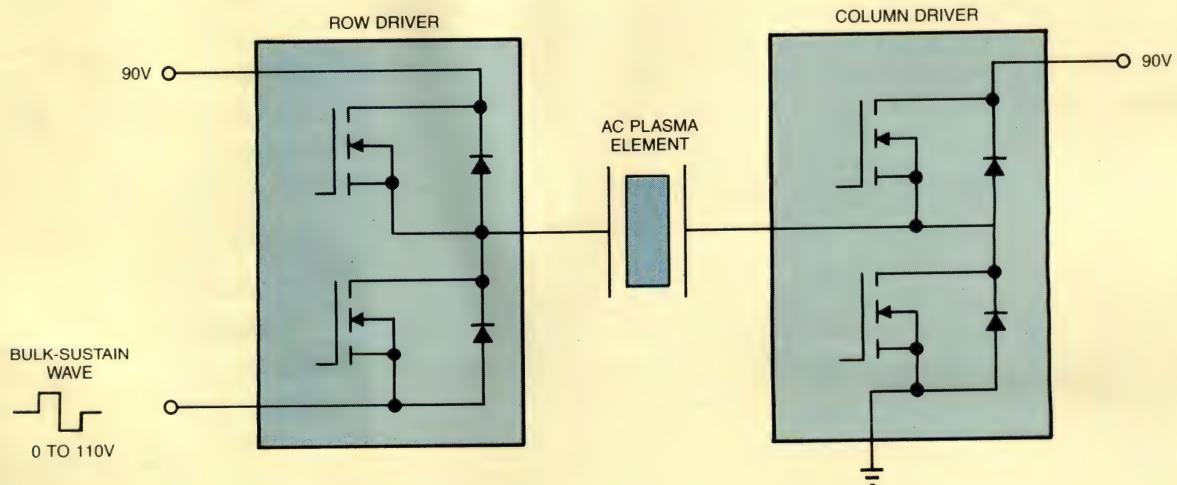
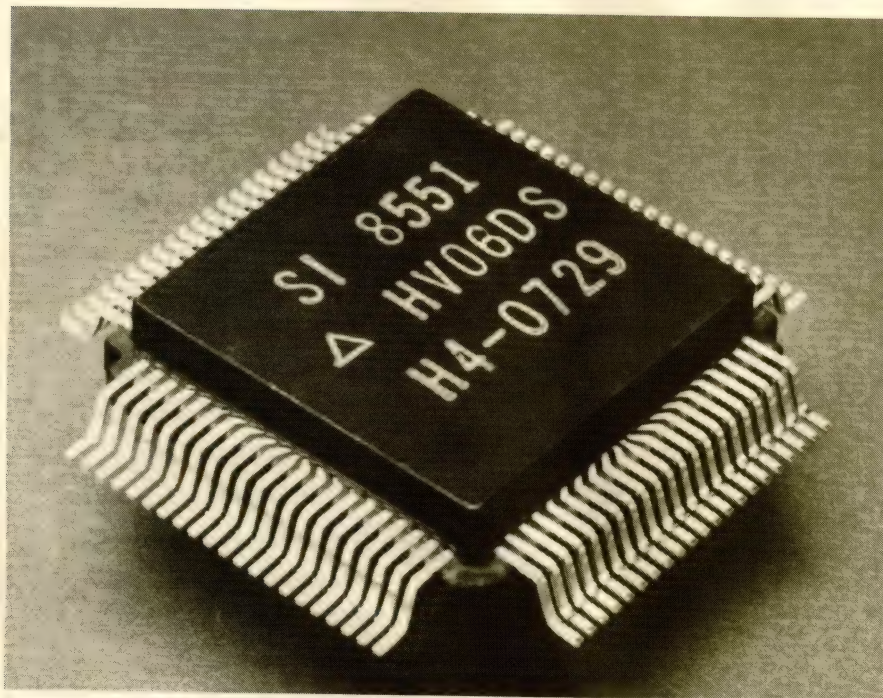


Fig B—The driver for an ac plasma display uses more complex waveforms than does an EL-display driver. Both the row driver and the column driver can have the same voltage inputs, but the row-driver input floats on a square wave called a bulk-sustain wave.

TECHNOLOGY UPDATE



Measuring only 65 in. on each side, this 64-channel display driver in an 84-lead gull-wing quad package from Supertex occupies about the same area as a standard 44-lead, 32-channel driver.

TI employs BIFET technology in all of its high-voltage driver circuits. It's a mature technology that has a high production yield, which translates into a cost-competitive line of products. Although critics of the BIFET process argue that replacing TI's bipolar devices with MOS circuits would dramatically increase driver efficiency and reduce heat dissipation, the company notes that bipolar transistors offer superior current-handling capability per unit of silicon area. Furthermore, as in Sprague's BiMOS II circuits, the

bipolar structures are generally unaffected by input conditions that can damage some MOS circuits.

In December of 1985, TI introduced its SN75557/SN75558 EL driver chips. Unlike most EL row drivers, which boast 200V or greater voltage outputs and current limits of 100 mA or less, the TI chips provide 100V outputs and sink 300 mA. Originally built according to the specifications of a particular display, TI decided to offer the chips on the open market.

The high-current outputs of these

32-bit drivers give you more power for multiplexing channels to drive large EL displays. The output sequence of the SN75558 is the reverse of the SN75557 for ease in laying out pc boards. Each chip has a 32-bit shift register, 32 AND gates, and 32 output OR gates. A serial-data output pin allows you to cascade drivers for use with large displays. These chips only come in 44-pin plastic leaded chip carriers. They operate over the 0 to 70°C temperature range, or over an extended range of -40 to +85°C for automotive applications. Each costs \$6.96 (100).

Another recent introduction is TI's 32-channel 100V ac plasma display drivers, the SN75508 and SN75509. These parts share identical specs, but the pinouts dictate very different wiring techniques from those previously noted for the SN75557/SN75558 chip set. The chips come in 44-pin plastic leaded chip carriers, offer an extended operating range of -40 to 85°C, and cost \$11.68 (100).

All-MOS junction isolation

The junction-isolation process used in Supertex's line of high-voltage display drivers employs silicon-gate CMOS input logic and complementary DMOS output switches, built on an epitaxial layer grown from the chip's substrate. The resulting IC features p- diffusion regions that surround lightly doped n wells. Row drivers have outputs that are open-drain switches, sinking current through the IC's n channels. The outputs of the column drivers are push-pull devices that use p channels for sourcing current and n channels for sinking it. This ability to provide MOS switches for both the sourcing and the sinking functions allows the resulting devices to reach higher switching speeds, achieve wider voltage handling capability, and consume about half the power of similar BIFET drivers.

Supertex began its research into

For more information . . .

For more information on the plasma and EL display drivers described in this article, contact the following manufacturers directly or circle the appropriate numbers on the Information Retrieval Service card.

Sharp Electronics Corp
10 Sharp Plaza
Paramus, NJ 07652
(201) 265-5600
Circle No 720

Sprague Electric Co
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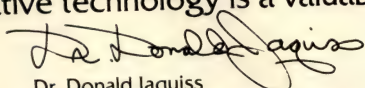
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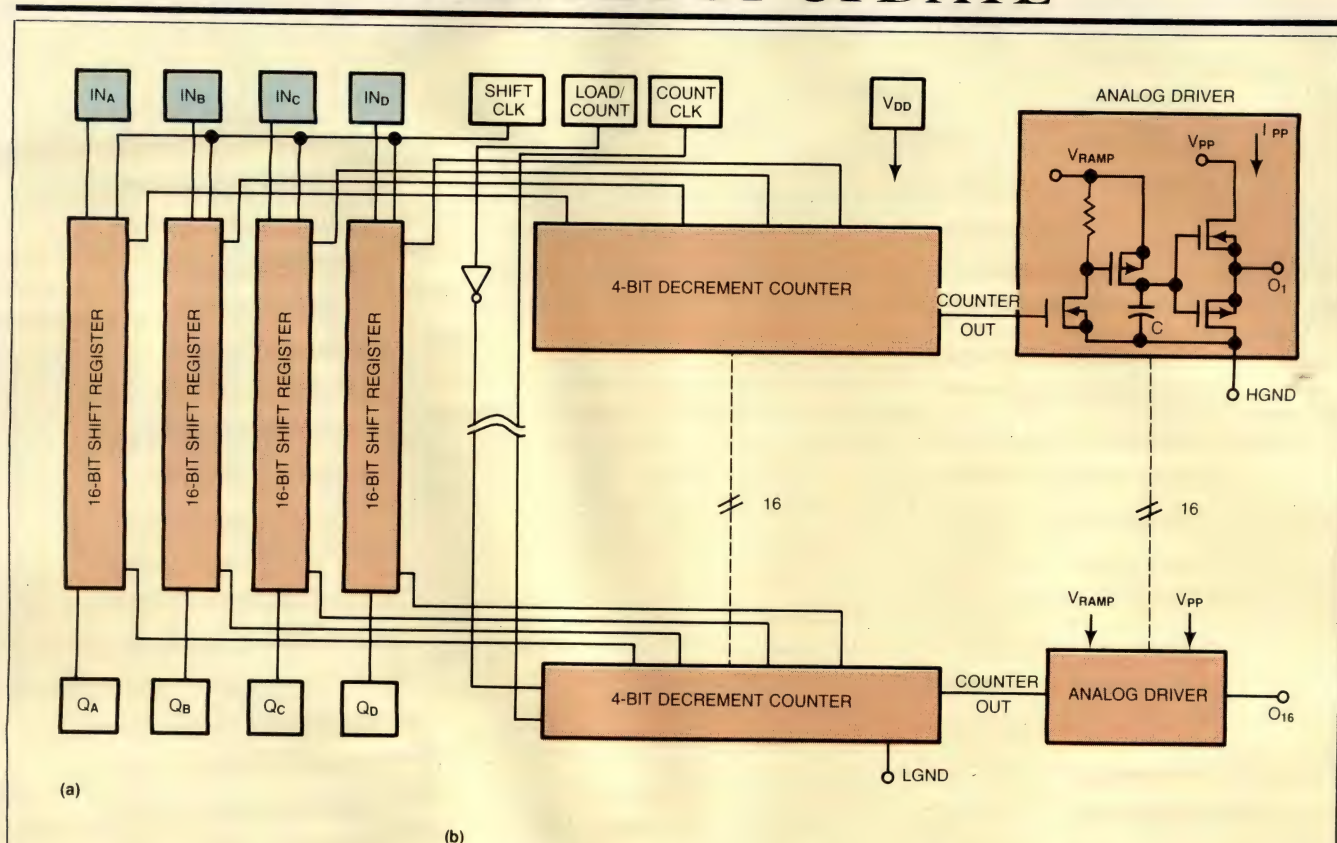


Fig 1—The HV01 is the only high-voltage display driver with 16-level gray-shading. When using the Supertex part, you control the intensity of a pixel's illumination by altering inputs IN_A through IN_D (a) according to the values given in the truth table (b).

junction isolation in 1980, and it currently offers 16-, 32-, and 64-channel plasma and EL drivers based on this technology. The HV01, one of the company's first EL-display drivers, remains the only driver IC on the market that offers gray-level intensity modulation (Fig 1). It costs \$37.21 (1000).

In an effort to offer a denser chip—and perhaps to match the area occupied by TI's 32-channel drivers—Supertex introduced a 0.65-in², 64-channel, 84-lead EL driver during the last quarter of 1985, priced at \$15.70 (1000). Now the first quarter of 1986 finds Supertex offering sample quantities of a 32-channel EL chip set that can fit in the area occupied by a comparable set of TI driver chips. Target pricing for commercial-grade drivers in plastic, J-leaded surface-mount packages is under \$4; hi-rel,

hermetically sealed drivers cost less than \$40 in OEM quantities.

Self isolation: one layer less

Supertex simplified the BIFET process by eliminating bipolar devices and creating an all-MOS part. In turn, Siliconix Inc's self-isolation process is a simplification of junction isolation. As in a junction-isolation display driver, Siliconix uses CMOS inputs and DMOS outputs in its EL-driver chip set. Performance differences between the two technologies are difficult to ascertain.

The self-isolation process does, however, eliminate the epitaxial layer that lies above the substrate in junction-isolation devices. This simplification reduces the number of mask-processing steps by one. The absence of the epitaxial layer also changes the structure of the devices on the chip: n- wells contain p-channel MOSFETs (PMOS), while the p- substrate itself helps compose n-channel DMOS transistors.

Because the self-isolation process is a relatively new technology in the high-voltage-driver area, it will

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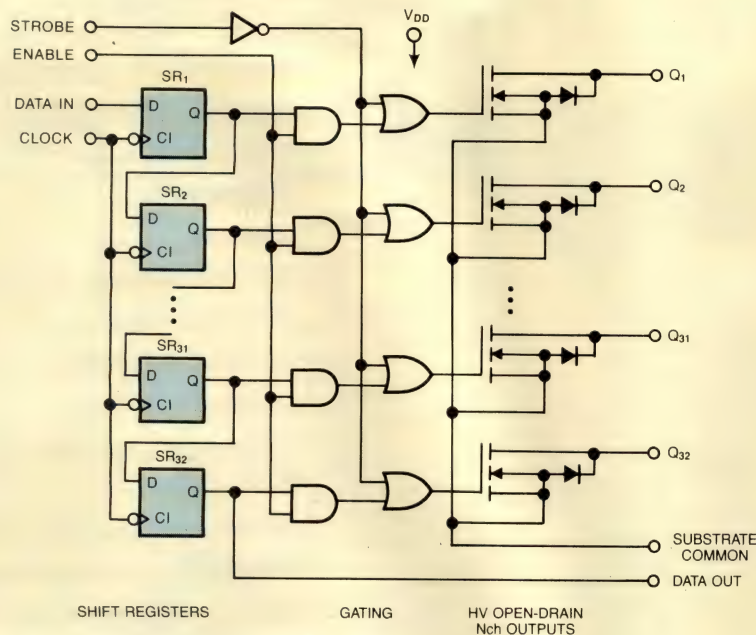
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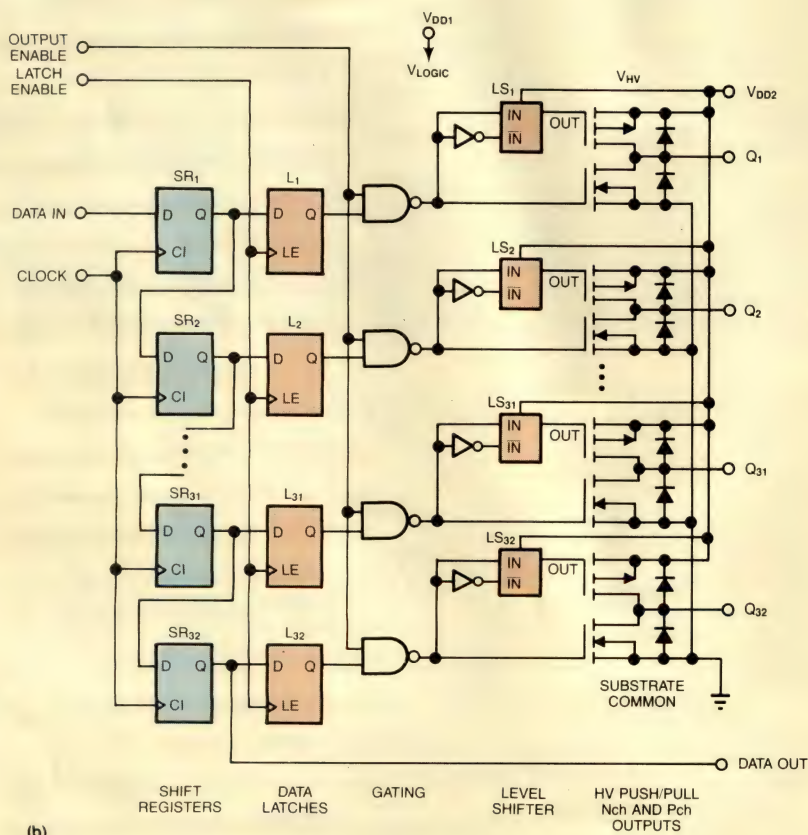
Access to the right technology

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(a)



(b)

Fig 2—To show the logic differences between row drivers (a) and column drivers (b), these block diagrams of Siliconix driver chips illustrate the added bank of data latches and level shifters in the column driver, the open-drain row-driver outputs, and the push-pull column-driver outputs.

take time for production runs to attain a high yield. Still, Siliconix believes that the process, by eliminating one mask-processing step, will eventually lead to lower manufacturing costs.

Siliconix introduced its EL drivers during the last quarter of 1985. The SI9551 and SI9552 EL row drivers and SI9553, SI9554, SI9555, and SI9556 EL column drivers are pin compatible with TI's SN75551/2/3/4/5/6 EL-driver chip set. But because the Siliconix chips are based on self-isolation technology, they offer faster performance, greater drive capability, and lower power consumption than the BIFET-based chips.

The 32-channel Siliconix row drivers have a 4-MHz, 32-bit shift register and 32 open-drain DMOS output devices rated at 225V and 80 mA. The column drivers have a 10-MHz, 32-bit shift register, a 32-bit latch, and 32 totem-pole outputs (Fig 2). The outputs are rated at 60 or 90V and sink or source as much as 15 mA. If the standard 0 to 70°C temperature range isn't adequate, you can specify a military range of -55 to 125°C. The devices are available in ceramic, 44-pin, J-lead packages, in 44-pin plastic leaded chip carriers, or in chip form for tab bonding. Prices range from \$5.40 to \$29.02 (1000).

Its own best customer

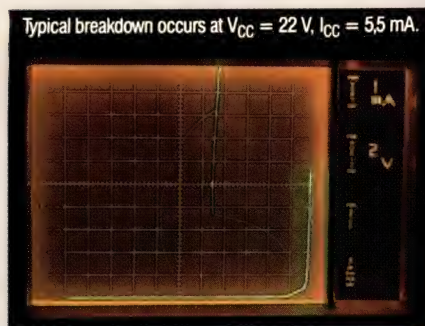
Sharp Electronics Corp got into the display-driver business because the calculators and instruments it manufactures have displays—typically of the liquid-crystal and LED variety. However, the company does produce an EL driver that's been around for years. The LZ-1032AM is a 32-channel driver housed in a 42-pin DIP. The 4-MHz LZ-1032AM accepts an input-voltage range of -0.4 to +7V and delivers an output-voltage range of -0.4 to +300V. The chip specs a current-drive capacity of 45 mA and an operating temperature range of -20 to +70°C. It costs \$48.97 (100).

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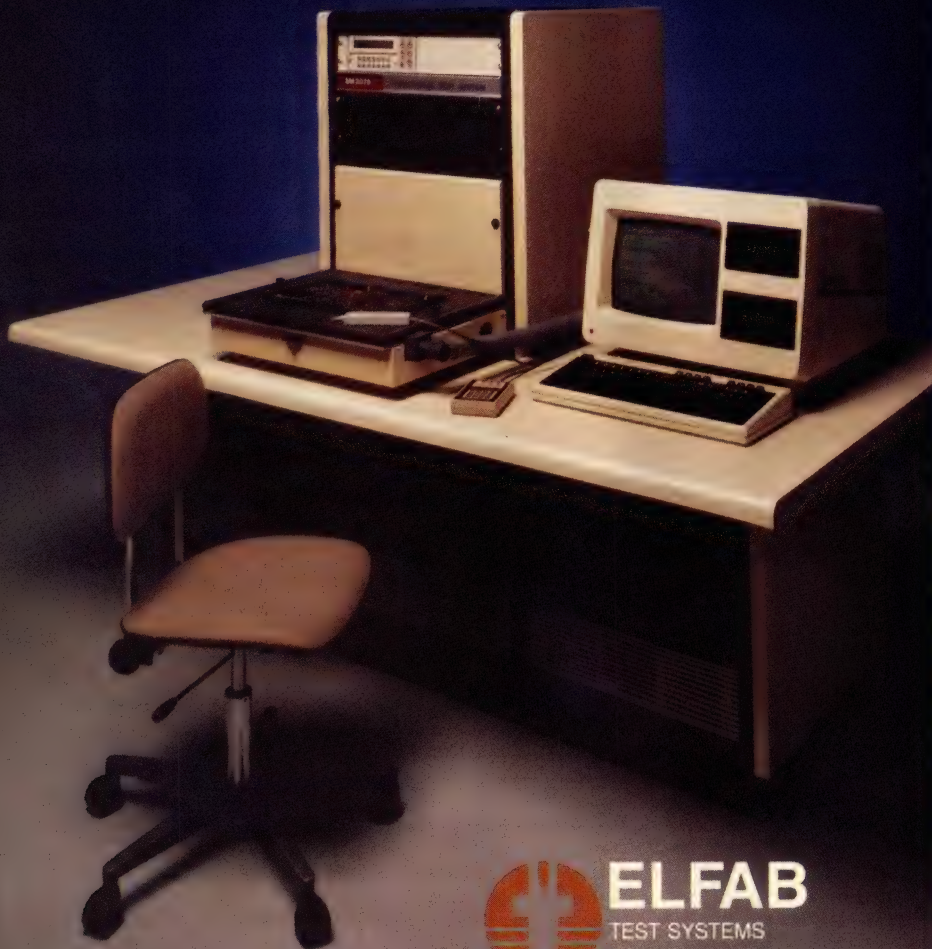
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For specialized applications that require driver output voltages greater than 400V, Telmos Inc's dielectric-isolation process is most suitable. Using a glass well between each component and the substrate, this process offers excellent isolation—ie, each active component in effect has its own surge protector. During normal operation, these components behave like typical row and column drivers. But if excessive avalanche current begins to flow—as in a shorted load condition—the dielectric isolation produces a current-clamping effect.

The dielectric isolation process also lets you create high-voltage CMOS circuits. You can make such circuits using junction- or self-isolation technologies, because the substrate is common to all the components in the device. Furthermore, this process allows you to define variations in ground.

Telmos's driver chips are custom products, requiring approximately a year of development and manufacturing time, combined with the monetary expense associated with custom-made ICs. However, each driver can switch a maximum of 450V, and you can stack them to double your voltage capacity. **EDN**

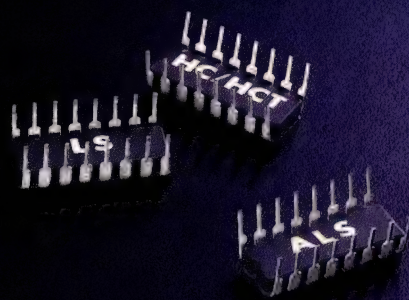
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2. *Display Driver Handbook*, Texas Instruments Inc, Dallas, TX, 1983.

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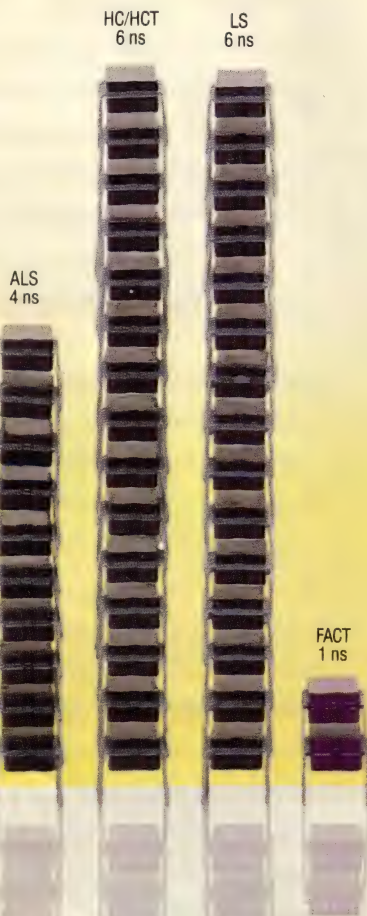
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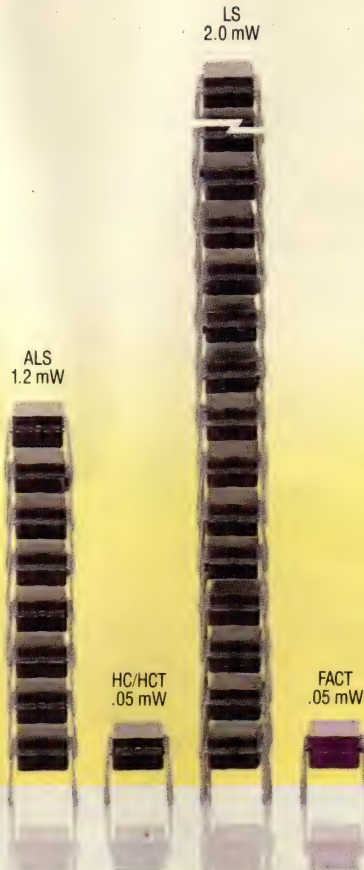


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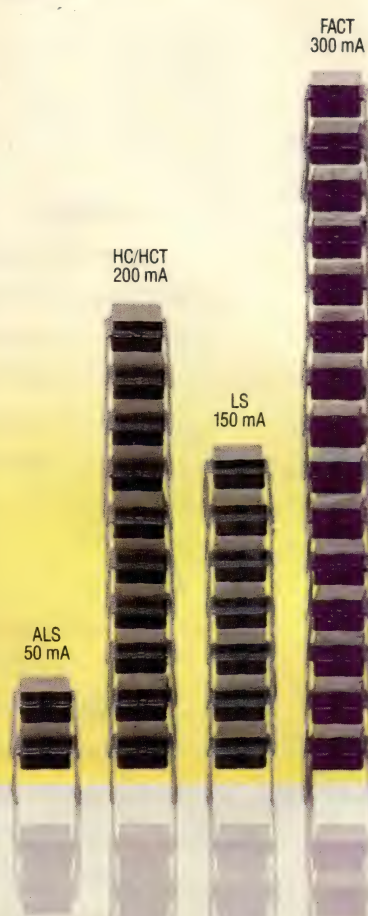
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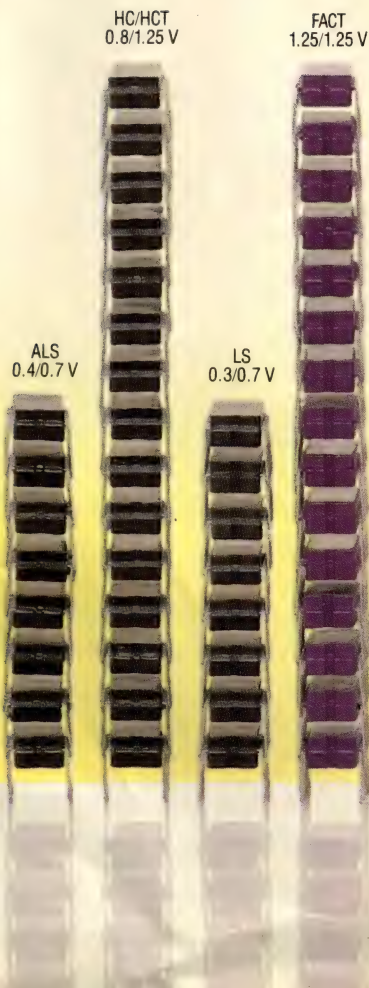


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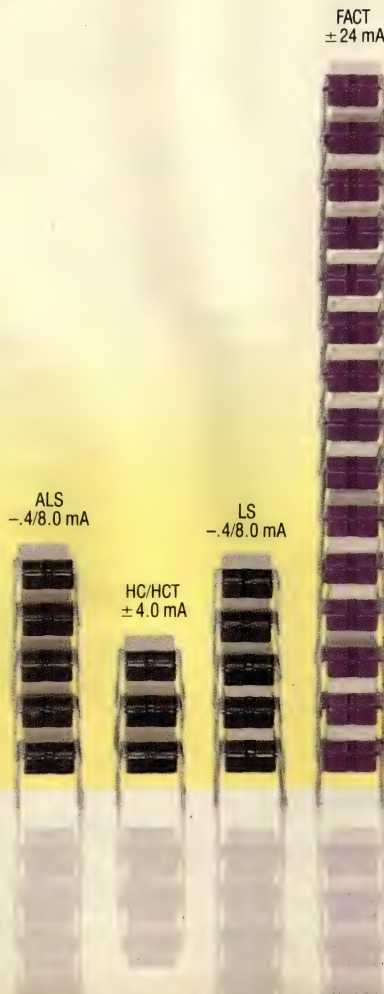
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Analog testing and PC hosts boost the capabilities of Winchester disk testers

Steven H Leibson,
Southwestern Editor

Employing such techniques as analog testing and PC hosting, the latest Winchester disk-drive testers offer improved test times and better performance than did earlier models. For high-capacity Winchester drives, for example, testers that perform analog surface testing can drastically reduce test times over those offered by digital testers. At the same time, these analog testers give you greater confidence of finding flawed tracks. Further, many testers now use personal computers as hosts, which greatly improves both the testers' user interface and their data-logging abilities. Some new testers can even help you debug your hard-disk subsystem and fine tune it for maximum performance.

Testers that perform window-margin testing take the clock and data signals from the drive and then skew the clock forward and backward in time, trying to force the data pulse outside the data window. Such a test evaluates the performance of a drive's read channel—including media, heads, and read circuitry—and provides a pass/fail indication. If the data pulses fall within the effectively reduced window, they pass; if they fall outside the window, they fail.

Phase-margin testing is similar to window-margin testing, except that a tester that performs phase-margin testing doesn't skew the clock. Instead, it measures the actual deviation of each data pulse from the theoretical center of the data window. The tester uses information from this test to create a histogram of phase deviation for the disk drive;



A PC supplies the user interface and data-logging capability for eight Model 506 Winchester disk drive analyzers from KJ Instruments.

the histogram gives an indication of the built-in margin.

The classical method of surface scanning (or defect mapping) is to perform several digital write/read cycles on every track. By varying the data pattern written and relying on the inherent positional variation that occurs when the same track is written repeatedly, disk-drive analyzers can generate flaw maps.

The number of passes per track you choose to make with a digital surface scan depends on the confidence level you require of the test. Most testers are programmable—that is, they let you specify passes per track.

Testers that use digital readback to identify flaws rely on reading a

pattern previously written on the disk media, so they actually test only the points where flux transitions occur on a track. You can attempt to maximize test coverage by using multiple passes and varied data patterns, but no matter how many times you write data patterns on a track, you won't be able to ensure that you've tested every spot on every track. Furthermore, although these multiple-pass tests take only 15 minutes for a 5M- or 10M-byte disk, they can take many hours for a Winchester disk drive with a capacity of several hundred megabytes.

Testers that perform analog surface scans, however, can create a flaw map for large-capacity hard-disk drives in a much shorter peri-

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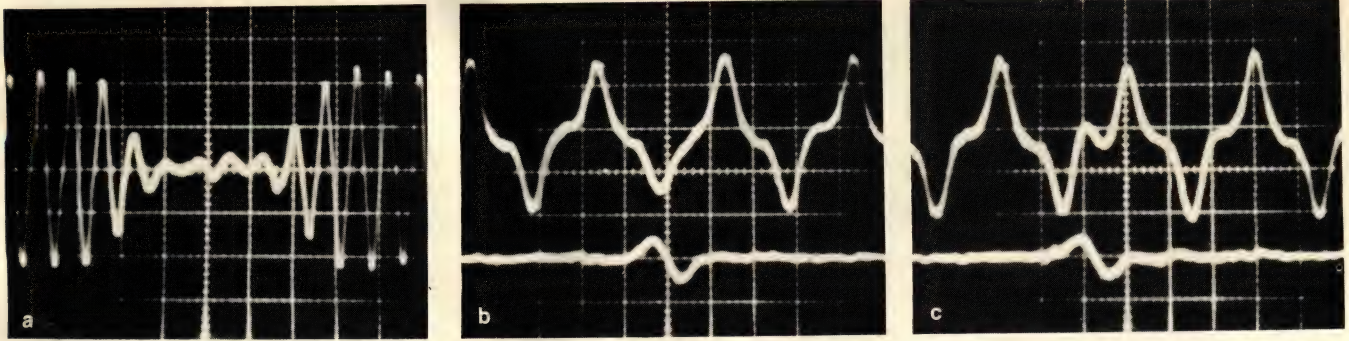


Fig 1—Large media flaws cause signal loss over several bits (a) and can easily be detected with digital write/read or missing-pulse tests. Flaws smaller than one bit, however, can have various effects, such as slight signal loss (b, top trace) or an extra peak (c, top trace)

depending on where the flaw occurs within the bit. DC-erasing the track produces the isolated, flaw-induced pulses shown in the bottom traces in b and c. These flaw-induced pulses are more easily detected by the extra-pulse test. (Photos courtesy Luctor Corp.)

od. Besides reducing rewrite cycles, these analog testers give you greater confidence of covering every spot on every track. Analog testers generally perform two tests: a missing-pulse test and an extra-pulse test.

The missing-pulse test uses an analog instead of a digital read channel to read back a written pattern. By measuring pulse height and comparing it to the average, you can discover flaws that a digital tester might miss. Note, however, that unless the drive has a special analog interface, you can't use its standard interface connectors to connect the drive to the tester. Instead, you must attach special analog probes to the appropriate nodes on the drive's electronics board so that the tester can sense the analog signals.

Testers that use the analog-readback technique look at the signal directly from the head amplifier and seek a pulse with too low an amplitude. Typically, these testers use a threshold of 80% of the track's average pulse-amplitude height to look for flaws. In contrast, testers using digital readback look at the data signal at a drive's digital interface and rely on the drive electronics to take analog signals from the head and convert them to digital signals. The drive electronics try to make all pulses look good at the interface, thus masking some poorly shaped pulses.

Although the missing-pulse test can find flaws that digital techniques miss, it still relies on a previ-

ously written pattern. Like a digital tester, therefore, an analog tester using a missing-pulse test can test the disk only where magnetic-flux changes reside.

Unlike window-margin, phase-margin, and missing-pulse testing, however, extra-pulse testing doesn't read back written patterns. Using the extra-pulse technique, a tester first dc-erases a track and then tries to read a signal from that track. Because no pattern exists on the media, any pulses that the tester reads from the erased track indicate media flaws.

Furthermore, to test each track, an extra-pulse test requires only two rotations of the media—one for the dc erase and one for the analog readback. With its analog-readback technique, extra-pulse testing can find very small media flaws.

Catching small media flaws

A digital write/read or missing-pulse test can easily detect a large media flaw, which produces a gross reduction in signal amplitude (**Fig 1a**) and affects several bits on a track. Media flaws smaller than one bit, however, affect only a single pulse and may cause signal loss or gain, peak shift, or additional peaks (**Figs 1b** and **1c**, top traces), depending on where the flaw occurs in relation to the pattern's magnetic-flux transitions.

If your analyzer uses digital write/read or missing-pulse tests, which attempt to read back a writ-

ten pattern, it may miss these small media flaws. The superimposition effects of the written and flaw-induced transitions are unpredictable and vary with time (pattern rewrite) and temperature.

The lower traces in **Figs 1b** and **1c** show a small, flaw-induced pulse that remains after a track has been dc-erased. A sufficiently sensitive analog tester could detect such a small pulse by using the extra-pulse test. Because this test encounters pulses with low signal levels, Luctor Corp recommends that you use linear supplies to power the disk drive during testing, thus reducing noise and making your extra-pulse test even more reliable.

Luctor's TIM-188 test module runs both the missing-pulse and extra-pulse tests; phase-margin and window-margin testing are optional. The TIM-188's analog read channel features a 30-MHz bandwidth, a 30-dB dynamic input range, and a 40-dB signal-to-noise ratio. The TIM-188, which costs \$24,000, is designed to be controlled by a host PC. The tester, which has no built-in user interface, communicates with the PC over a standard, asynchronous serial interface.

Offering digital, missing-pulse, and extra-pulse tests, the DATS-1000 and -2000 testers from Wilson Laboratories use a 3-step process to map flaws. First, they perform both missing-pulse and extra-pulse tests, identifying suspect tracks. At this point, you can choose to perform a

TECHNOLOGY UPDATE

digital surface scan to further identify suspect tracks.

Next, a missing-pulse test reexamines the suspect tracks, using a tougher set of test parameters. This second scan identifies tracks that have large missing-pulse errors. The analyzer identifies failing tracks in the flaw map and then subjects all remaining suspect tracks to between 100 and 200 digital write/read cycles. The tester then identifies failing tracks in the flaw

map and considers the remaining tracks to be good.

This 3-step process reduces test time by using the multiple-pass, digital surface scan to test only the tracks on the suspect list. The company claims that its DATS-1000 and -2000 testers provide greater reliability than testers that use other methods, because suspect tracks that pass a DATS tester's digital scan have survived hundreds of test passes. Tracks not on the suspect

list have been tested with one or two passes of the digital scan. The DATS-1000 costs from \$9975 to \$11,900; the -2000 sells for \$12,250 to \$14,975.

Many tester manufacturers are beginning to offer Winchester disk drive testers that operate with a host PC because of PCs' relatively low cost. KJ Instruments' Model 506 disk-drive analyzer, for example, is driven by a PC over a serial interface. The \$3500 tester comes

LOW-COST WINCHESTER DISK TESTERS

MANUFACTURER	MODEL	PRICE	DISK INTERFACE	DIGITAL TESTS	WINDOW MARGIN	PHASE MARGIN	MISSING PULSE	EXTRA PULSE	PROGRAMMABLE DRIVE POWER SUPPLIES	REMOTE COMPUTER INTERFACE	DATA-LOGGING INTERFACE
APPLIED CIRCUIT TECHNOLOGY	DTS	\$7650	ST506/412 ESDI	YES	YES	NO	NO	NO	NO	NO	SERIAL AND PARALLEL
	ADTS	\$9000-\$14,000	ST506/412 ESDI	YES	YES	YES	YES	YES	YES	SERIAL	SERIAL AND PARALLEL
APPLIED DATA COMMUNICATIONS	T-650	\$9995-\$13,700	ST506/412 SA1000/Q2000	YES	YES	YES	NO	NO	NO	NO	SERIAL
	TIA-150	\$10,000-\$12,000	ANALOG HEAD OUTPUT	NO	YES	YES	NO	NO	NO	IEEE-488	OPTIONAL SCREEN, PRINTER
APPLIED MEMORY TECHNOLOGY	DX525	\$2675	ST506/412	YES	YES	NO	NO	NO	NO	NO	PARALLEL
	DX525AT	\$4750	ST506/412	YES	YES	NO	NO	NO	ON/OFF	NO	PARALLEL
	DX525AT/D	\$5500	ST506/412 ESDI	YES	NO	NO	NO	NO	ON/OFF	SERIAL	PARALLEL
	DX525ADX	\$8500	ST506/412 ESDI	YES	YES	YES	YES	YES	ON/OFF	SERIAL	SERIAL AND PARALLEL
BRIAN INSTRUMENTS	HARD-ALIGN 2.2	\$5995	ST506/412	YES	YES	NO	NO	NO	NO	SERIAL (OPTIONAL)	OPTIONAL
CAMBRIAN SYSTEMS	WIN-SPECTOR CS-1000	\$6950	ST506/412 ESDI (JUNE '86)	YES	YES	NO	NO	NO	NO	SERIAL NETWORK	SERIAL AND PARALLEL
FLEXSTAR	FS5000	\$4985	ST506/412	YES	NO	YES	NO	NO	NO	SERIAL	SERIAL
	FS5500	\$8485	ST506/412	YES	NO	YES	YES	YES	NO	SERIAL	SERIAL
	FS8500	\$12,000	ST506/412	YES	NO	YES	YES	YES	NO	SERIAL	SERIAL
	FS8600	\$15,000	ESDI	YES	NO	YES	YES	YES	NO	SERIAL	SERIAL
KJ INSTRUMENTS	506	\$3500	ST506/412	YES	YES	NO	NO	NO	NO	SERIAL	NONE
LUCTOR	TIM-188	\$24,000	ST506/412, ESDI, SMD	YES	OPTIONAL	OPTIONAL	YES	YES	NO	YES	NONE
PIONEER RESEARCH	PM4000	\$5198-\$6700	SMD	YES	YES	NO	NO	NO	NO	SERIAL	SERIAL
	PR4001	\$7950	ST506/412 ESDI	YES	NO	NO	NO	NO	ON/OFF	SERIAL	SERIAL
WILSON LABORATORIES	DATS-1000	\$9975-\$11,900	ST506/412 ESDI	YES	YES	YES	YES	YES	NO	SERIAL	SERIAL
	DATS-2000	\$12,250-\$14,975	ST506/412 ESDI	YES	YES	YES	YES	YES	YES	SERIAL	SERIAL
	DTS-1000	\$8995-\$12,321	ST506/412 ESDI	YES	YES	NO	NO	NO	YES	SERIAL	SERIAL
	MWX-1000	\$7495-\$9983	ST506/412 SA1000, ESDI, SMD	YES	YES	NO	NO	NO	NO	SERIAL	SERIAL
XEBEC	1000	\$1995	ST506/412	YES	YES	NO	NO	NO	YES	HOST ADAPTER	NO

Catch it... Plot it!

Our PM 3305 35 MHz digital storage oscilloscope adds plot capability to 10 ns, 4-channel glitch capture. So even at a sweep speed of 5s/div, you can catch a glitch and make hard copy via an analog x-y recorder or a digital colour plotter; such as our PM 8154 or any HP-GL compatible plotter. But there's no catch to the PM 3305's many other features such as:

■ **Low price.** It's the most cost-conscious DSO of its type on the market. Yet it has valuable extras like analog-to-digital conversion; X-Y display; external clock drive, and an IEEE/IEC option.

■ **High performance.** It has dual-slope triggering, 4K pre-trigger ability and a selective memory expansion of up to x 40. **Single-shot event capture**, also with automatic reset for next event.

Test the difference

■ **Product credibility** in technology, technique, quality and service because the PM 3305 is backed by the vast corporate resources of one of the world's largest electronics companies.



Test the difference and you'll also agree that Philips wins on price and performance!

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**Test &
Measurement**

CIRCLE NO 62

PHILIPS

TECHNOLOGY UPDATE

with a menu-driven test program that runs on an IBM PC or similar computer. You can assemble complex test sequences by selecting from entries listed in the extensive set of nested menus. Available tests include seek, timing, window margin, and write/read. A test editor allows you to modify existing tests and make new tests by combining test programs.

KJ Instruments offers a \$30 demonstration disk that lets you experiment with the company's software on your IBM PC or compatible computer. The disk contains sample data so that you can configure and run tests without the Model 506 tester.

Another PC-driven tester, the \$1995 Model 1000 disk-test system from Xebec, is based on a modified version of the company's S1410 disk controller and communicates with a host PC over an SASI interface. A host adapter card for the IBM PC bus comes with the tester. The Model 1000 offers window-margin testing and programmable disk power supplies for "four-corners" testing, which allows you to operate

Disk-testing conference

To investigate the technical considerations of disk testing in depth, you can attend the Technology Assessment Group's Disktest conference. The next Disktest conference will be held in San Jose, CA, in August or September of this year and will feature exhibits by disk-drive-tester manufacturers.

For more information, contact Technology Assessment Group Inc, 351 South Hitchcock Way, B-160, Santa Barbara, CA 93105. Phone (805) 963-8081.

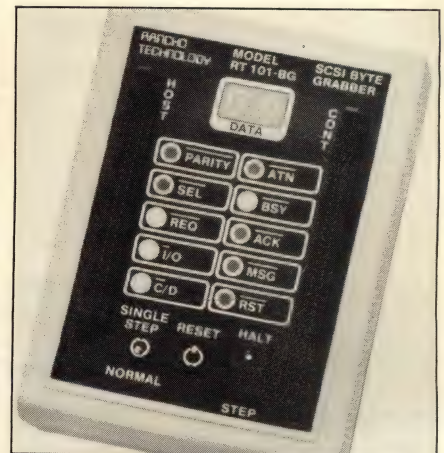
the disk drive under test at minimum and maximum voltage conditions on both the 5V and 12V power lines.

Using a PC for tester control offers several benefits. Data logging and analysis is easier on testers with PC hosts than on testers that use dedicated, proprietary hardware. Furthermore, PC-based-tester control programs let you store results on disk for later analysis. You can choose from any of the PC's programming languages or statistics programs to analyze your data, and you can use printers, plotters, and graphics packages to create listings and plots of test results.

Although most disk testers evalu-

ate drives, some manufacturers now offer test systems designed to aid in the development of disk subsystems. Adaptec offers the \$19,500 SDS-1 SCSI development system, which includes an IBM PC/XT, graphics printer, 2M-byte SCSI host adapter, and software.

The SDS-1 controls and monitors a SCSI bus. You can test a drive's performance by using a SCSI-compatible disk-drive controller to operate the drive, to evaluate the performance of several drives under one controller, to compare controller performance by using a single drive with different controllers, and to test the latest drives that feature integral SCSI interfaces. A state



For development and debugging, Model RT 101-BG Byte Grabber from Rancho Technology can monitor a SCSI bus. In single-step mode, the tester locks the bus handshake on each transaction until you press a step switch.

Offering digital, missing-pulse, extra-pulse, and phase-margin testing, the DATS-2000 from Wilson Laboratories can test four Winchester drives sequentially without operator intervention.

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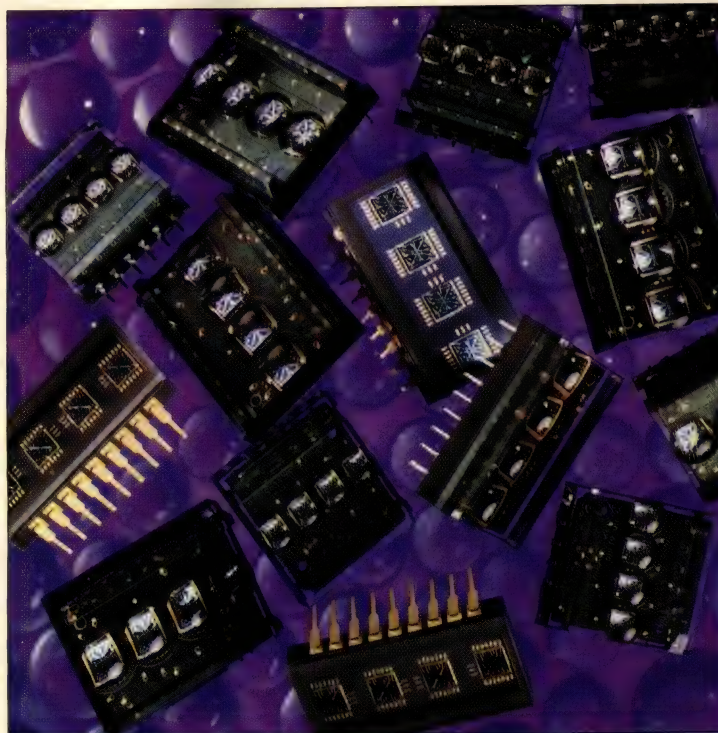
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TECHNOLOGY UPDATE

log records all bus transactions, so you can use the SDS-1 as a SCSI-bus logic analyzer.

The SDS-1 offers a menu-driven interface for easy sequencing of commands over the SCSI interface. If you need to test sequences in real time, you can use the Microsoft C compiler and SCSI test-function library, both of which come with the test system. The function library offers both programmed and random REQ/ACK handshake timing, and it can test error-recovery routines by forcing error conditions.

The SDS-1 is useful in regression testing because it generates repeatable tests that can run independently of an operator. Regression testing ensures that product enhancements and modifications won't compromise overall product performance or operation.

Another SCSI-development product is the SAE SCSI application exerciser from Rancho Technology. Included with the company's \$275 RT 2003-PC SCSI host adapter board for the IBM PC bus, the SAE

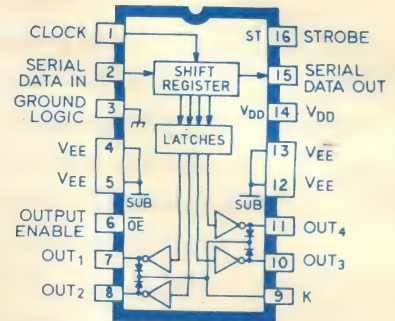
program allows you to exercise SCSI devices either in an interactive mode or through batch files. You use the SAE to control SCSI devices through the host adapter board. The SAE also supports a bus-monitoring mode. A source license for the SAE code costs \$2000.

The company also offers the RT 101-BG SCSI Byte Grabber, which works on any SCSI bus. The tester, which costs \$380, monitors traffic on the SCSI bus, displaying data on a 2-digit hexadecimal display and showing the control-line status on 10 LEDs. You use a switch to select free-running operation or single-step mode. In single-step mode, the tester locks the bus handshake on each transaction until you press a step switch. A reset switch allows you to reset all SCSI devices on the bus without resetting the host system.

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SMART PIC



**UCN-5826B BiMOS II
HIGH-CURRENT SERIAL-INPUT
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- Write for Engineering Bulletin 26185.3 or:
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For more information . . .

For more information on the Winchester disk drive testers described in this article, circle the appropriate numbers on the Information Service Retrieval card or contact the following manufacturers directly.

Adaptec Inc
580 Cottonwood Dr
Milpitas, CA 95035
(408) 946-8600
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Anaheim, CA 92806
(714) 632-9230
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Flexstar Corp
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Rancho Technology
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Tustin, CA 92680
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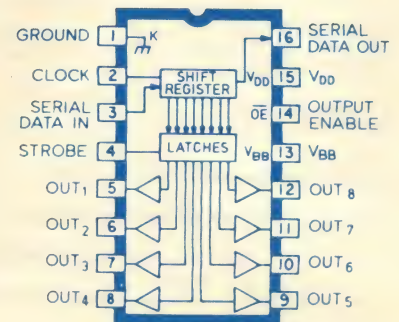
Wilson Laboratories Inc
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Orange, CA 92665
(714) 998-1980
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Applied Memory Technology
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Tustin, CA 92680
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(602) 864-1298
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Sprague Electric Company, a Penn Central unit, Worldwide Hdqtrs., Lexington, MA. Integrated Circuit Division, Worcester, MA. For applications assistance, call Mark Heisig or Tom Truax at 617/853-5000 or write for Brochure WR-203 to Technical Literature Service, Sprague Electric Company, 41 Hampden Road, Mansfield, MA 02048-1807.



CIRCLE NO 61

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**Cypress Semiconductor. We've been shipping 1.2
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35ns.



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trons go
shortened
they have to
alt: 15ns.



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1K x 4 SRAM.

also shown - 4x larger than
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faster, uses less power. It
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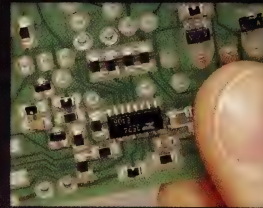
unique Veri-Drive Plus which increases switching efficiency and improves reliability.

Todd's MDT series meets all international safety standards. These switching power supplies are approximately 30% smaller in size than the industry average. The 160 and 220 watt series offer a choice of 18 models only 9" x 5" x 2.5". Or choose from 16 models in the MDT 300 and 400 watt series only 11.5" x 5" x 2.5".

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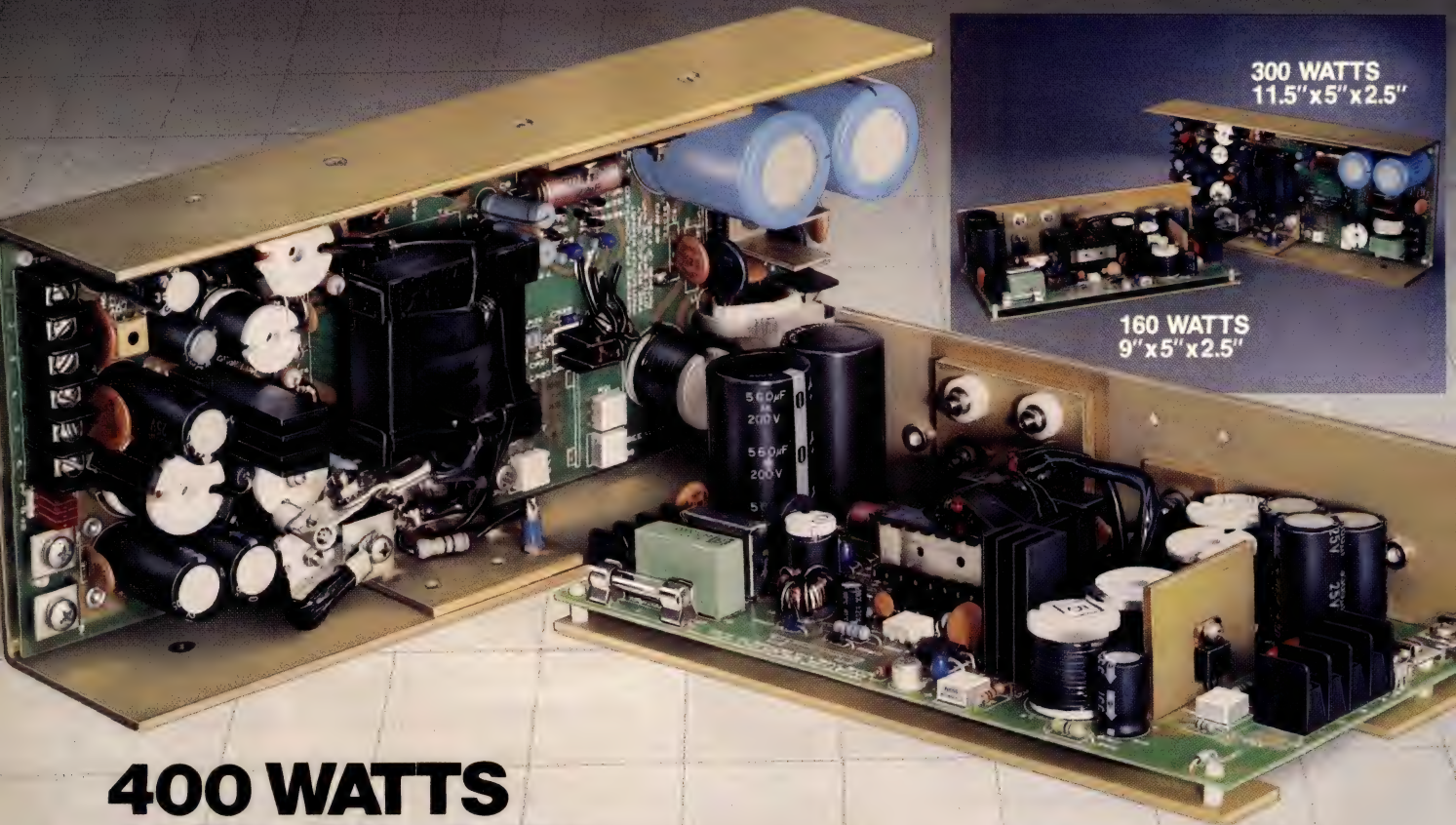
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Surface mount technology reduces size and increases reliability.

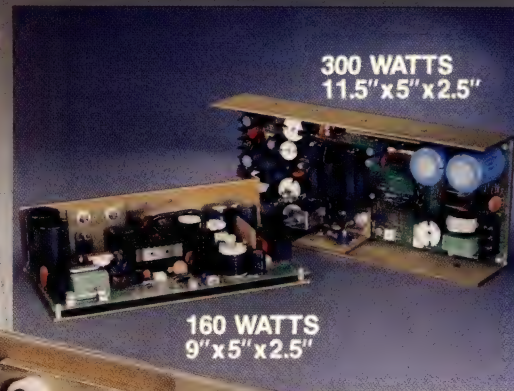
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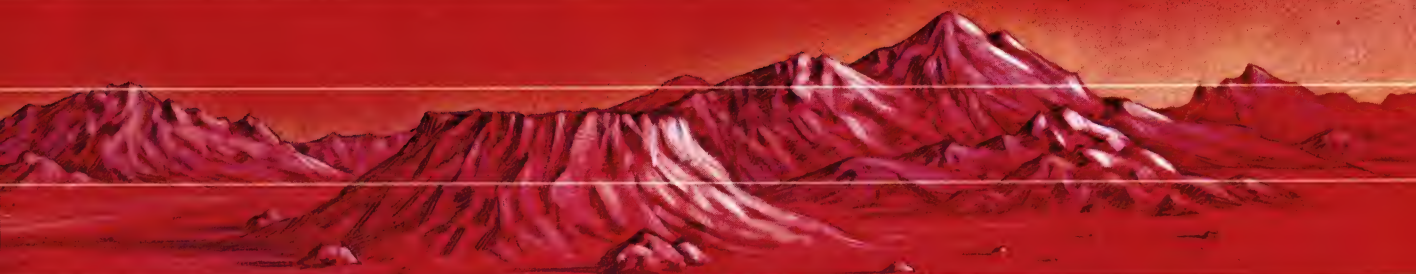
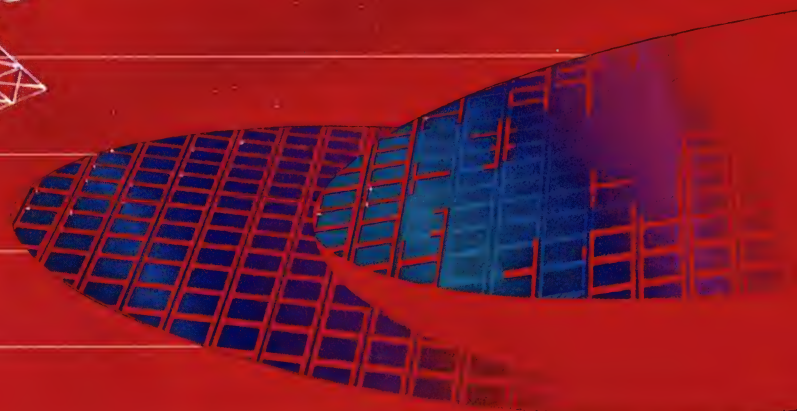
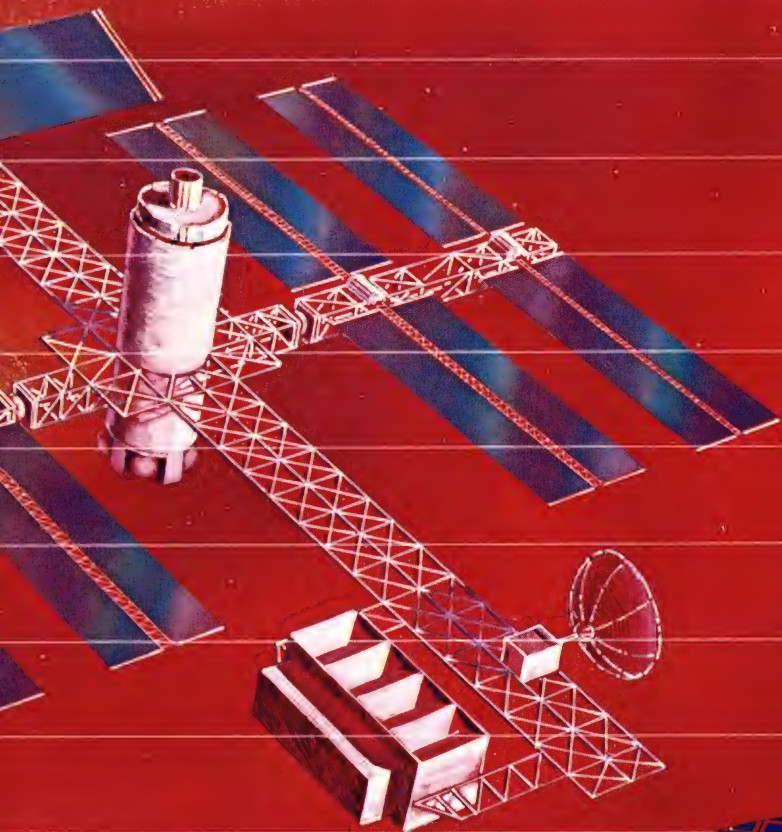
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The transducer uses an interactively laser-trimmed 4-stage network to perform signal conditioning. The first stage (A_1 in **Fig 1**) compensates for the temperature coefficient of offset inherent in a semiconductor pressure sensor. It also provides a high input impedance, preventing loading of the S-signal output. The sensor performs offset compensation by comparing

the temperature-varying S-signal output to a fixed reference voltage that's precisely defined through interactive laser trimming.

The second stage (A_2) performs the differential to single-ended conversion necessary to provide a ground-referenced output. It also provides the majority of system gain and some buffering. A_3 is a precision voltage reference that calibrates the zero pressure offset of the entire system, which comprises the sensor offset and the input offset voltages of A_1 , A_2 , and A_4 .

The fourth stage (A_4) provides the full-scale span calibration. Resistor R_{SPAN} combines with standard self-compensation techniques to compensate for the temperature coefficient of span.

MPX3100 Series transducers, which cost \$62 (100), have a 0 to 15 psi (0 to 100 kPa) measurement-range capability. Their typical burst pressure specs at 150 psi, and their full-scale span ranges from 2.9 to 3.1V. The sensors' zero pressure offset equals 0.6V max. Their typical sensitivity specs at 30 mV/kPa,

and their linearity measures $\pm 0.2\%$ FS typ.

The devices are compensated for operation over 0 to 85°C. Temperature effects on hysteresis, full-scale span, and offset spec at $\pm 0.5\%$ FS, $\pm 1\%$ FS, and ± 50 mV, respectively. They operate from a 5V excitation source and offer a response time (10 to 90%) of 10 msec.

MPX3100 Series transducers are available in differential and gauge configurations. They come in a basic-element package (MPX3100D) or in a housing that includes pressure fittings and offers differential (MPXS3100DP), gauge (MPX3100GP), or gauge-vacuum (MPX3100GVP) measurement capabilities. The plastic ports accept standard $\frac{1}{8}$ -in. ID tubing and are molded from high-temperature thermoplastic that can withstand temperature extremes from -40 to $+125^\circ\text{C}$.

—Tom Ormond

Motorola Semiconductor Products, Box 2953, Phoenix, AZ 85008. Phone (602) 244-6900.

Circle No 740

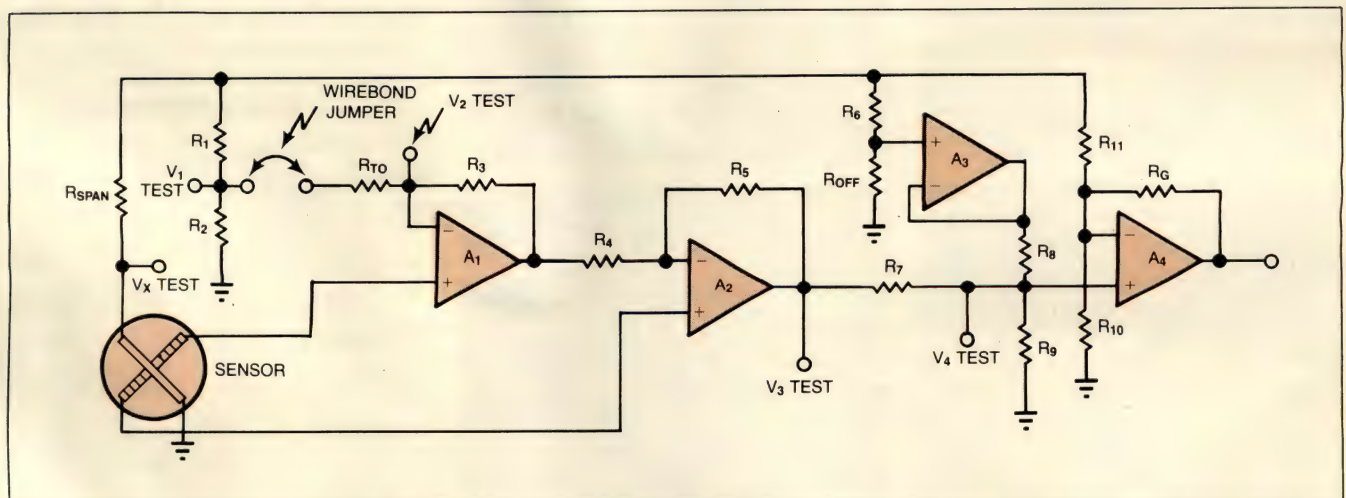


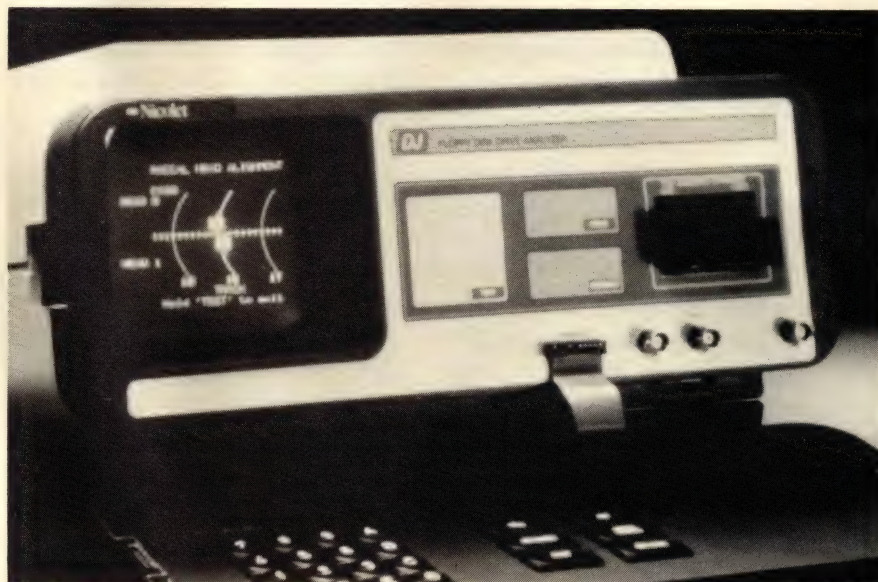
Fig 1—Offering μ P-compatible outputs, the MPX3100 Series pressure transducers feature a 4-stage, laser-trimmed signal-conditioning system that provides a temperature-compensated, calibrated, 3V nominal output when the sensors are working with a 5V excitation source.

Floppy-disk-drive analyzer displays real-time graphics on its CRT

You can use the 887-DJ analyzer, along with an alignment diskette and interface cable, to test and align 3½-, 5¼-, and 8-in. floppy-disk drives having FM and MFM data formats. Instead of making you interpret the raw signals from a disk drive, the tester produces physically meaningful graphics displays on its CRT.

A removable, EEPROM-based test cartridge on the front panel stores your preprogrammed test sequences, drive specifications, and pass/fail criteria for one drive. You need one test cartridge for each drive model you test.

You can remove the keyboard (which you use for configuring the analyzer and creating test sequences), leaving only three keys (Test, Print, and Restart) on the front panel. With this simplified configuration, you can run tests loaded from the EEPROM test car-



You can test 3½-, 5¼-, and 8-in. floppy-disk drives with the 887-DJ analyzer from Nicolet. A CRT display provides real-time information for each test.

tridge, but you can't modify them. You can print results either of a single test or of the entire test sequence. By pressing the restart but-

ton, you can go to the previous test, and by holding the button down, you can abort and restart the entire test sequence.

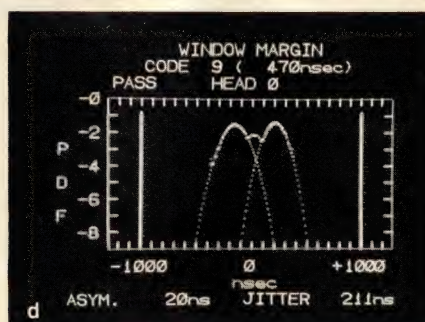
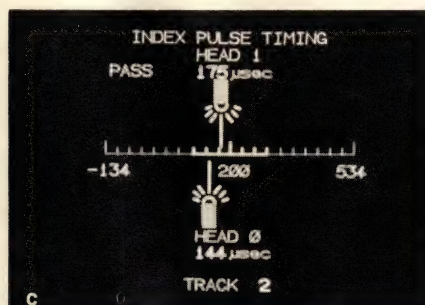
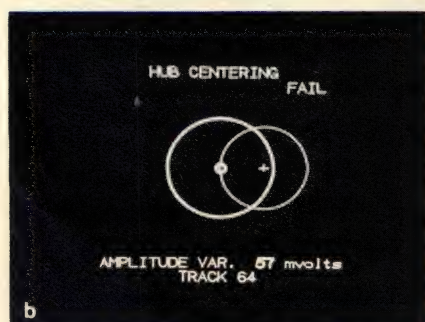
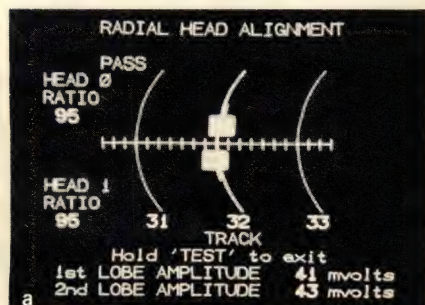
The 887-DJ can perform analog, timing, digital, and window-margin tests. The analog tests evaluate the drive's write protection, head signal amplitude and resolution, spindle-rotation speed, track 00 sensor, radial alignment and hysteresis, azimuth, index-pulse timing, skew, and hub centering. The timing tests evaluate data pulse width, head load, track-seek settling, and motor-start times.

The analyzer performs both sequential and random write/read tests. In addition, you can format diskettes on the drive under test. The Model 887-DJ analyzer costs \$8500; extra 888-88 EEPROM test cartridges cost \$100 each.

—Steven H Leibson

Nicolet Oscilloscope Div, 5225 Verona Rd, Madison, WI 53711. Phone (608) 273-5008.

Circle No 741



A graphic display, including a pass/fail evaluation, accompanies each test that the 887-DJ analyzer performs. The analyzer tests a drive's radial head alignment (a), hub centering, (b), index-pulse timing (c), and window margin (d).



Hughes' Connector Line: When You Care Enough to Spec the Very Best.

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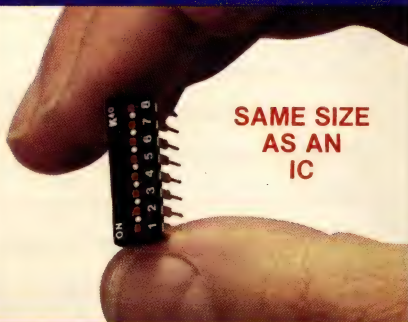
- And our MIL-C-28876 fiber optic connector, the only multi-channel type to meet mil spec.

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PRODUCT UPDATE

Plug-in board and software run 68000 code on Apple II

By adding the R68 board to your Apple II, II+, or IIe computer, you can write and execute programs for the MC68000 μ P. The plug-in board includes a 68000 processor, resident firmware, and an Applesoft support package. The board has its own memory and interrupt hardware, so it can run independently of the Apple's μ P.

The board's 68000 μ P runs at 8 MHz (or, optionally, at 10 or 12 MHz) with no wait states. Onboard memory consists of 48k bytes of RAM and 8k bytes of EPROM. You can have the manufacturer add a daughter board to the R68 that increases the RAM to 256k bytes.

The board includes ports for user I/O and for communication between the Apple and 68000 μ Ps. Four 8-bit ports connect the 68000 to the computer through four of the 16 addresses assigned to the slot in which you insert the board. You connect ribbon cables to the board to use its two 8-bit bidirectional I/O ports or serial I/O port. A 6522 chip controls the I/O ports, and it implements either the serial port or the 8-bit ports under user control. All ports are interrupt driven; the hardware supports eight levels of interrupts.

The R68 comes with software and

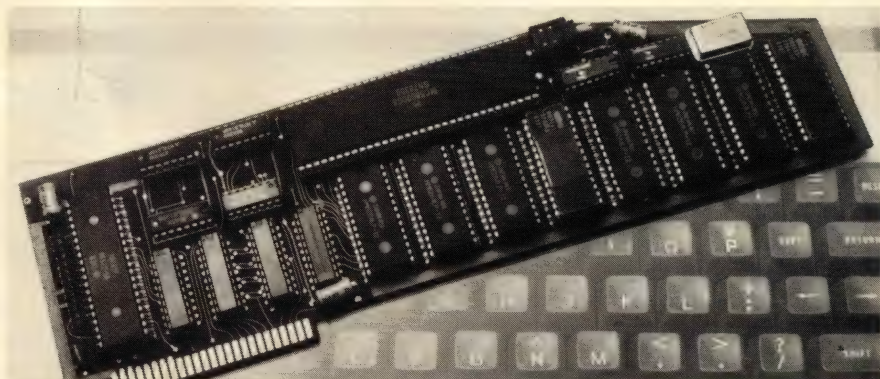
onboard firmware for developing and executing programs for the 68000. The firmware includes monitoring functions and task- and interrupt-handling routines. Application programs developed with the R68's software have access to the 26 firmware commands, which include upload, download, memory display, memory modification, execution manipulation, breakpoint manipulation, debug, and memory test. The software also includes the S-C Macro assembler from S-C Software Corp (Dallas, TX).

You can use the R68 to learn about programming the 68000, to execute 68000 programs, and to perform digital signal processing of data collected by the company's digital-oscilloscope and spectrum-analyzer peripherals for Apple computers. The board runs independently of the Apple; you can reboot the computer and run other programs without affecting the R68's operation. The system comes with a 68000 manual, an assembler manual, and system documentation. \$499.

—David Smith

Rapid Systems Inc, 755 N Northlake Way, Seattle, WA 98103. Phone (206) 547-8311.

Circle No 742



You can develop and run 68000 programs on your Apple II computer by installing the R68 system. The system includes a 68000 coprocessing board, firmware, and a software-development package.

In the world of CMOS design, your competition is fierce.



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*FAST is a trademark of Fairchild Semiconductor Corp.

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**RCA**

LEADTIME INDEX

Percentage of respondents

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Last month's average (weeks)	Average (weeks)
TRANSFORMERS								
Toroidal	7	22	57	14	0	0	7.2	11.3
Pot-Core	8	23	46	23	0	0	7.8	9.3
Laminate (power)	0	14	72	14	0	0	8.3	8.4
CONNECTORS								
Military panel	10	30	50	10	0	0	6.2	8.0
Flat/Cable	26	42	21	11	0	0	4.3	3.5
Multipin circular	13	20	47	13	70	0	8.1	7.6
PC	13	50	31	6	0	0	4.4	4.5
RF/Coaxial	13	53	20	7	7	0	5.6	5.6
Socket	29	48	14	9	0	0	3.5	3.4
Terminal blocks	17	46	29	8	0	0	4.5	3.7
Edge card	11	53	31	5	0	0	4.3	4.4
Subminiature	7	36	50	70	0	0	5.8	2.8
Rack & panel	10	40	40	10	0	0	5.6	5.6
Power	27	46	27	0	0	0	3.1	6.9
PRINTED CIRCUIT BOARDS								
Single-sided	0	65	35	0	0	0	4.1	4.1
Double-sided	0	50	50	0	0	0	5.0	5.0
Multilayer	0	47	47	6	0	0	5.7	9.8
Prototype	10	80	10	0	0	0	2.4	2.0
RESISTORS								
Carbon film	32	36	28	4	0	0	3.6	3.0
Carbon composition	29	29	38	4	0	0	4.3	5.2
Metal film	36	32	29	3	0	0	3.4	3.0
Metal oxide	21	36	43	0	0	0	4.2	3.7
Wirewound	22	35	35	8	0	0	4.9	4.7
Potentiometers	31	35	25	9	0	0	4.1	5.2
Networks	42	37	21	0	0	0	2.4	5.2
FUSES								
	57	17	17	9	0	0	3.1	2.5
SWITCHES								
Pushbutton	34	33	22	11	0	0	4.2	4.7
Rotary	13	20	47	20	0	0	7.4	7.3
Rocker	25	34	33	8	0	0	4.6	6.3
Thumbwheel	8	59	25	8	0	0	4.5	9.8
Snap action	33	33	20	14	0	0	4.9	5.3
Momentary	7	57	22	14	0	0	5.1	5.8
Dual in-line	10	60	20	10	0	0	4.4	5.6
WIRE AND CABLE								
Coaxial	39	59	11	0	0	0	1.9	3.2
Flat ribbon	45	36	14	5	0	0	2.6	1.6
Multiconductor	38	33	29	0	0	0	3.0	2.4
Hookup	58	32	10	0	0	0	1.4	1.7
Wire wrap	72	14	7	7	0	0	2.0	2.7
Power cords	27	32	32	9	0	0	4.6	3.2
Other	25	12	50	13	0	0	6.3	2.4
POWER SUPPLIES								
Switching	0	41	47	12	7	0	6.5	8.4
Linear	6	50	25	19	9	0	6.0	8.7
CIRCUIT BREAKERS								
	6	35	30	29	0	0	7.7	7.8
HEAT SINKS								
	23	41	24	12	0	0	4.7	6.0

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Last month's average (weeks)	Average (weeks)
RELAYS								
General purpose	29	24	33	14	0	0	5.4	5.0
PC board	13	27	33	27	0	0	7.5	7.6
Dry reed	0	46	36	18	0	0	6.7	6.0
Mercury	0	50	38	12	17	0	6.0	9.0
Solid state	9	18	46	27	8	0	8.3	8.8
DISCRETE SEMICONDUCTORS								
Diode	29	32	26	13	0	0	4.8	5.5
Zener	34	31	21	14	0	0	4.5	4.8
Thyristor	24	29	29	18	0	0	5.8	6.1
Small signal transistor	31	17	35	17	0	0	5.9	5.7
FET, MOS	24	18	35	18	5	0	7.3	12.6
Power, bipolar	22	7	50	21	0	0	7.5	8.1
INTEGRATED CIRCUITS, DIGITAL								
CMOS	20	32	32	16	0	0	5.8	7.4
TTL	22	30	26	22	0	0	6.2	9.0
LS	33	19	24	24	0	0	6.1	8.3
INTEGRATED CIRCUITS, LINEAR								
Communication/Circuit	0	20	60	20	0	0	8.4	9.8
OP amplifier	10	32	37	21	0	0	7.0	8.1
Voltage regulator	14	34	33	19	0	0	6.4	7.2
MEMORY CIRCUITS								
RAM 16k	7	40	20	33	0	0	7.7	8.0
RAM 64k	26	32	16	26	0	0	8.7	6.2
RAM 256k	7	29	43	21	0	0	7.4	7.8
ROM/PROM	8	17	42	33	0	0	9.0	8.0
EPROM	18	41	18	23	0	0	5.9	6.5
EEPROM	8	25	42	25	0	0	7.9	9.1
DISPLAYS								
Panel meters	0	46	45	9	0	0	6.0	5.6
Fluorescent	0	0	57	43	0	0	11.4	6.5
Incandescent	0	37	38	25	0	0	7.8	5.6
LED	14	45	27	14	0	0	5.3	6.2
Liquid crystal	13	25	50	12	0	0	6.4	8.3
MICROPROCESSOR ICs								
8-bit	26	26	32	11	5	0	6.1	6.4
16-bit	19	19	50	6	6	0	6.9	11.3
FUNCTION PACKAGES								
Amplifier	18	9	46	27	0	0	8.2	6.2
Converter, analog to digital	7	29	43	21	0	0	7.4	7.2
Converter, digital to analog	9	18	46	27	0	0	8.4	8.6
LINE FILTERS								
	18	9	55	18	0	0	7.5	7.4
CAPACITORS								
Ceramic	34	33	26	7	0	0	3.9	3.9
Ceramic monolithic	25	42	25	8	0	0	4.1	4.4
Ceramic disc	35	22	30	13	0	0	4.9	4.2
Film	14	33	43	10	0	0	5.7	6.3
Electrolytic	21	21	42	12	4	0	6.7	6.0
Tantalum	26	26	33	11	4	0	6.0	6.2
INDUCTORS								
	18	23	47	12	0	0	6.1	6.3

Source: Electronics Purchasing magazine's electronics business survey

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ABBOTT M300 SWITCHING POWER SUPPLY SERIES

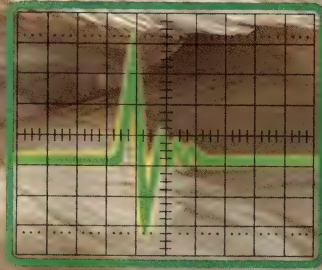
DIMENSIONS

Input frequency	47-440 Hz
Input voltage	115 V ac $\pm 10\%$
Output power	300 watts (5 V, ± 12 V; or ± 15 V)
Efficiency	60% minimum
Hold up time	10 m Sec
Ripple/noise	100 mV peak-to-peak maximum
Line regulation	0.2% or 25 mV
Load regulation	0.2% or 25 mV
EMI	Meets MIL-STD-461B**
Environment	Meets MIL-STD-810C, MIL-S-901C
Input protection	Per MIL-STD-1399
Operating temperature range	0°C to +71°C
Storage temperature range	-55°C to +85°C
MTBF* (Ground benign)	60,000 Hrs.
ER option	134,228 Hrs.
MTBF* (Naval sheltered)	11,000 Hrs.
ER option	28,000 Hrs.

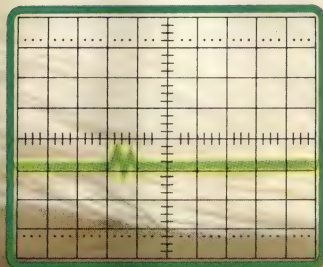
*MIL-HDBK-217D (50°C baseplate temp.)

**Refer to spec sheet for applicable levels.

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Piezo Film is an excellent ultrasonic transmitter.

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Computers: Switches and keyboards; input devices such as digitizers, sketch

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P ressure Sensors & Transducers



Designers of pressure sensors and transducers are striving to improve price and performance figures to satisfy the needs of a growing variety of applications. In particular, the levels of integration now available in IC-based devices are maintaining performance levels while reducing costs.

Tom Ormond, *Senior Editor*

Manufacturers of pressure sensors and transducers are continuing to refine device designs, improve performance and reliability, and reduce costs. Some vendors are using new fabrication techniques to improve reliability. Many are also miniaturizing their products. There's also a trend toward more complex sensors that include a good deal of electronics within the transducer package itself.

The most basic level of integration involves the addition of passive components (either on a sensor chip or ceramic substrate) to perform the basic signal-conditioning functions such as zeroing, temperature compensation, and sensitivity calibration. Some manufacturers also include active devices to develop high-level output signals. Then there's functional integration, which involves the addition of new functions that complement and enhance sensor performance. This type of integration relies on recent developments in micromachining achieved by companies like NovaSensor and Transensory Devices.

Micromachining is the 3-D sculpturing of silicon to form mechanical structures. As it is applied to sensors, micromachining today provides a new arsenal of tools that will soon result in a new generation of more sophisticated devices. These intelligent sensors will include μ Ps and memory within the device (see **box**, "In a class by itself").

A number of techniques transform mechanical displacement into an electrical signal. The most common methods employed in commercial transducers are strain-gauge, variable-capacitance, LVDT (linear variable differential transformer), potentiometric, force-bal-

Prices of pressure sensors and transducers are falling because manufacturers are integrating active and passive devices and improving processing techniques. (Photo courtesy Motorola Inc)

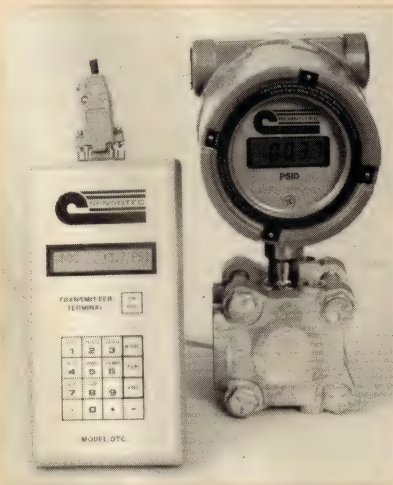


In a class by itself

The level of integration you can expect in future sensors will yield devices that can automatically correct data for nonlinearity and temperature effects. These smart devices will contain integral μ Ps and memory and will be able to transmit digital output data in engineering units and provide range-changing capability.

One such device is available now. A typical Sensotec DTP (which costs \$850 to \$1100, depending on measurement type and options) consists of a load or pressure sensor, a power supply, a programmed feedback amplifier (PFA), a μ P and memory, an address/data bus, A/D and D/A converters, a UART, and an excitation-supply regulator. The sensing element consists of a bonded, foil strain gauge (a Wheatstone bridge circuit) that provides an output proportional to the measured quantity. The power supply operates from an external, unregulated ± 15 or 28V dc source; this source is then regulated to provide excitation to the sensing element. The PFA then amplifies the low-level signal from the sensor.

The device's ROM stores the program steps and fixed constants and communicates with the μ P through the multiplexed



This highly integrated, μ P-based transducer, the DTP from Sensotec, provides simultaneous analog and digital output signals, automatic recalibration, and programmable correction for temperature effects and ambient pressure.

address/data bus. The sensor's RAM (actually an EEPROM) stores data used in the calculations, as well as alterable limits. The A/D converter is a 15-bit-plus-sign dual-slope integrator. It takes its reference potential from the excitation supply, thereby correcting for changes in the potential.

The UART interfaces the transducer with the transmission link. The UART is bidirectional, sending commands and operating values to the transducer, and sending data to the readout device. The D/A converter takes

digital output data and transforms it to one of two standard analog output values: 0 to 5V or 4 to 20 mA.

The μ P performs a number of functions. It monitors a 7-bit address code to determine which transducer should receive the transmission in question. It also detects a transmitted operation to determine any required change of operation. It translates gain information from the data system or calibrator to set up the gain of the PFA, and it stores these operating characteristics. The μ P times and controls the conversion of the transducer output to digital values, performing special corrections as indicated by any subroutines active at a given time. Finally, it transmits data upon request.

Transducer performance is impressive. The digital output is compatible with RS-485, RS-232C, or 20-mA loop interfaces. The maximum line pressure it can measure is 2000 psi. Available measurement ranges are 50 through 8000 in. of H_2O (differential), 1 through 30,000 psia, and 1 through 30,000 psig. Accuracy specs at $\pm 0.1\%$ FS. Operation spans -20 to $+180^\circ F$. The thermal effect on zero and span measures $\pm 0.005\%/^\circ F/FS$ and $\pm 0.005\%/^\circ F$, respectively.

ance, piezoelectric, and vibrating-wire techniques. The most radical technology developments are occurring with strain-gauge types. They come in several variations: bonded foil, diffused (piezoresistive), bonded semiconductor, and thin film.

The piezoresistive strain-gauge devices are at the forefront of sensor-technology development. The semiconductor manufacturers that make these devices have

the process experience to achieve higher levels of integration, and in doing so they have managed to reduce prices to the \$10 to \$15 range while maintaining the accuracy, output, and temperature-compensation capabilities customers have come to expect.

MPX2050 silicon piezoresistive pressure sensors from Motorola illustrate the level of integration available in today's solid-state sensors. The MPX2050 con-

The most basic level of electronic integration involves the addition of passive components for signal-conditioning functions.

sists of a monolithic shear-stress strain gauge, diffused thermistors, and a thin-film resistor network—all on one chip. Each chip is laser-trimmed for precise span and offset calibration. Laser-trimming also provides temperature compensation over a -40 to $+125^{\circ}\text{C}$ operating range.

The MPX2050's 0- to 40-mV analog output is highly linear over a 0- to 7.3-psi differential (psid) pressure range, which translates into 0 to 50 kPa. Linearity (ie, the maximum deviation from a straight-line fit from 0 to 50 kPa) at 25°C equals $\pm 0.1\%$ FS typ and $\pm 0.25\%$ FS max. Sensitivity specs at 0.8 mV/kPa, and typical zero-pressure offset is ± 0.05 mV. Temperature effects on hysteresis, full-scale span, and offset equal $\pm 0.5\%$ FS, $\pm 0.5\%$ FS, and ± 0.5 mV, respectively. Full-scale span is calibrated to 40 ± 1.5 mV for a 50-kPa pressure differential with a 10V supply.

MPX2050 Series sensors are available in a basic-element package for differential pressure measurements; differential, gauge, gauge-vacuum, gauge-axial, and gauge-vacuum/axial versions are also available. The devices cost \$15.20 (10,000).

The 16PC Series sensors from Micro Switch employ a 0.1-in² silicon chip with an integral sensing diaphragm and four piezoresistors. The four sensing resistors are connected as an active-element bridge for optimum linearity and sensitivity. Pressure applied to the diaphragm causes it to flex and change the resistance values of the bridge, thus developing a low-level output voltage that's proportional to pressure.

The line includes three measurement options; differential (16PCD), gauge (16PCG), and a choice of differential or gauge (16PCM). All three options are available in 0- to 5-psi, 0- to 15-psi, and 0- to 30-psi measurement ranges. They feature laser-trimmed resistors and a thermistor to provide low sensitivity shift and null shift with temperature. All the parts cost \$10 (5000).

Maximum null offset specs at ± 1 mV. Full-scale output equals 50, 100, and 79 mV for 5-, 15-, and 30-psi devices, respectively. Respective linearity figures range from ± 0.75 to ± 1.5 , ± 0.5 to ± 1.0 , and ± 0.3 to $\pm 0.5\%$ FS, and psi sensitivity equals 10.00, 6.67, and 2.63 mV. Over a 0 to 50°C operating range, null shift measures ± 2 mV, and sensitivity shift (at 10V dc) equals $\pm 1.5\%$ FS. Repeatability and hysteresis spec at $\pm 0.25\%$ FS.

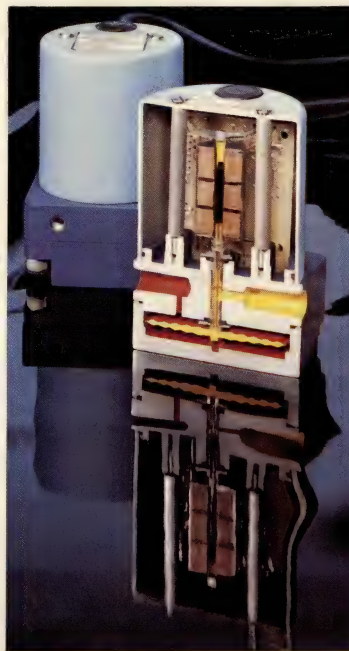
According to Micro Switch, the tape-automated-bonding (Tab) procedure used in assembling the 16PC Series provides bond strengths that are as much as 10 times stronger than conventional wire bonding. In

addition, only eight interconnections are necessary—a benefit when you consider that a reduced number of connections generally means increased reliability.

The 16PC sensors come in miniature black thermoplastic packages with O-ring seals, which allow the devices to handle a wider variety of pressure media—air, gas, liquid, etc. The pressure-sensitive diaphragm region is surrounded by the package's elastomer seal, leaving it exposed to pressure media applied through the ports, which are ultrasonically welded in place. You can select seal material to fit specific application requirements.

Model 33 from IC Sensors is a bidirectional, solid-state, piezoresistive transducer that's housed in a TO-8 can. The sensor accommodates corrosive or noncorrosive media through the bottom port and noncorrosive materials through the top port. The sensors interface with any liquid or gas medium that's compatible with the device's wetted materials—gold, silicon, and glass on the bottom port, and nickel and silicone on the top port.

The units cover a 0- to 250-psid measurement range



Able to take measurements as low as 0.1 psi, P-3000 Series sensors from Schaevitz are available with 0 to 5V dc, 0 to ± 5 V dc, or 4- to 20-mA outputs.

Long-term stability and high repeatability are key features of type-CA, -CC, and -CS transducers from D-J Instruments. The pressure transmitter shown on the left has a 4V dc output. Repeatability is 0.05% FS.



Pressure transducers can use strain-gauge elements to convert mechanical displacement into a proportional electronic signal.

in seven steps, spec $\pm 0.1\%$ accuracy, and feature integral laser-trimmed resistors to provide temperature compensation and calibration over 0 to 50°C. No external resistors are required.

An additional laser-trimmed resistor in the package allows you to normalize variations in different sensors' pressure sensitivities by programming the gain of an external amplifier. As a consequence, you can interchange sensors without varying sensitivity by more than $\pm 1\%$, and you can maintain a high output level.

Model 33 sensors are available in three performance grades: A, B, and C. With no external amplification, A-grade sensors have a 75- to 125-mV FS span and spec a ± 1 -mV zero-pressure output. Linearity equals $\pm 0.1\%$ of span, and pressure hysteresis equals $\pm 0.05\%$ of span.

Sensors bear more than rated pressure

B-grade sensors provide a 75- to 150-mV FS span and spec a ± 2 -mV zero-pressure output. Linearity and pressure hysteresis equal $\pm 0.25\%$ and $\pm 0.1\%$ of span, respectively. C-grade units have an FS of 50 mV min and spec a ± 5 mV zero-pressure output. Linearity equals $\pm 0.5\%$ of span, and pressure hysteresis equals $\pm 0.15\%$ of span.

All sensors will withstand three times the rated pressure. Typical supply current for guaranteed input/output ratiometricity spec at 1.5 mA. The operating

range is -40 to $+125^\circ\text{C}$. A-, B-, and C-grade sensors cost \$53, \$51, and \$35 (1000), respectively.

The IPT from Ametek is an industrial pressure transducer available in 0- to 15-psi and 0- to 5000-psi gauge, absolute, and differential ranges. They employ solid-state, silicon, piezoresistive pressure-sensing elements and a custom hybrid circuit that's laser-trimmed under computer control to obtain the nominal output and to provide precise temperature compensation over a -25 to $+75^\circ\text{C}$ range.

Four standard outputs are available: 0 to 50 mV, 0 to 100 mV, 4 to 20 mA, and 1 to 5V dc. Excitation voltage is either 10V dc or 15 to 45V dc, depending on the output selected. Thermal repeatability specs at 0.1%, and accuracy equals $\pm 0.5\%$ FS at 25°C . Combined temperature error measures 2% FS, and stability (over one year) equals $\pm 1\%$. Overpressure and burst pressure spec at 200 and 300%, respectively. Span equals 0.5% FS, and offset equals 0 ± 0.5 mV.

IPTs have a 5 k Ω (± 1 k Ω) output resistance and a 5- to 10-k Ω input resistance. Each device is 100% computer tested for temperature and accuracy performance, and unit interchangeability is guaranteed. The parts come in high-impact, corrosion-resistant Valox housings with $\frac{1}{8}$ - or $\frac{1}{4}$ -in. NPT (national taper pipe) threaded pressure ports. The price is \$15 (500).

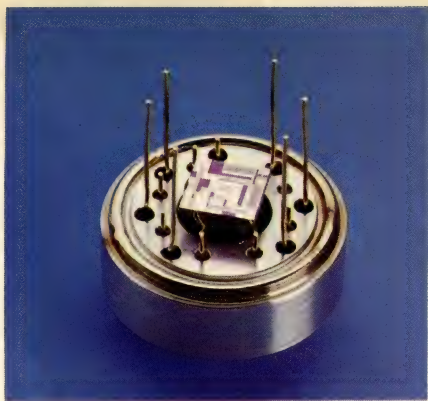
Like all the devices described thus far, Sensym's



Offering absolute, gauge, and differential measurement capability, Sensym's SX Series pressure transducers feature a 1- to 150-psi range and 0.1% FS accuracy.



Temperature compensation over a 32 to 200°F range is available in the Model 175A transducers from Robinson-Halpern. Five standard versions take measurements over a 500- to 5000-psig range.



Capable of handling hostile aerospace environments, Gulton's GMS 110 type pellicoidal pressure sensors employ a thin-film strain-gauge Wheatstone-bridge sensing element deposited on a silicon diaphragm. The deposition uses sputtering techniques rather than ion implantation.



Employing capacitance-sensing technology, Series 200 absolute pressure transducers from MKS Instruments can measure vacuum pressure down to 10^{-8} torr. Only the device's Iconel housing is exposed to the process gases, thus reducing corrosion problems.



Capable of operating while submerged, the PA194SH pressure transducer from West Coast Research draws only 1 mW and provides a 1V FS. The unit is available with an output converter or transmitter that provides a BCD, 4- to 20-mA, or 0 to 5V control signal.

semiconductor-type SX Series use a silicon diaphragm with the sensing bridges diffused into the silicon. The series includes 20 devices for measuring absolute, differential, and gauge pressures covering ranges from 0 to 1 psi through 0 to 150 psi. Transducer outputs range from 18 to 270 mV. Typical accuracy (linearity and hysteresis) specs at 0.1% FS. With a 4.5-k Ω bridge resistance, noise of less than 2 μ V p-p, and infinite resolution, the units are well suited to applications that require high accuracy.

SX01 (0 to 1 psi) and SX05 (0 to 5 psi) devices measure only gauge and differential pressures. Full-scale span (with 18V dc excitation) ranges from 36 to 60 mV. The typical zero-pressure offset for both devices specs at -40 mV. Repeatability equals 0.5% FS, and long-term stability specs at 0.1% FS. The devices operate over -40 to +85°C. Span and offset TCs measure -2300 ppm/°C and 4 μ V/V/°C, respectively.

The 15-, 30-, 100-, and 150-psi transducers have FS spans of 270, 270, 360, and 270 mV, respectively. Repeatability specs at 0.5% FS. The typical zero-pressure offset equals -40 mV, and the operating range is -40 to +85°C. Typical span and offset TCs equal -2150 ppm/°C and 4 μ V/V/°C.

Two package styles are available for all devices in the SX Series. A small, 0.5-in.-diameter plastic package is available for use in space-critical applications where the unit can be epoxied or sealed via O rings into a pressure-connection fixture. A compact N package (glass-filled nylon) is available for applications that

require pressure ports. Prices range from \$17.25 to \$20.25 (100).

Although the silicon-based sensors are showing the most activity in the advance of sensor technology, not all applications call for their use, so you'll continue to see a wide range of devices using other technologies. A number of sensors use stainless-steel rather than silicon diaphragms. The stainless steel is more impervious to corrosive media. What's more, the stainless-steel devices can reach higher measurement levels than those attained by silicon sensors.

Pacific Sensors' PS-500 and PS-501 Series transducers (\$235) are compact sensors designed for applications in which accuracy and reliability are prime considerations. They employ a sensing element that consists of a Wheatstone bridge-type strain gauge bonded to the stainless-steel diaphragm. Standard adapters are available for 1/4-in. NPT threaded ports and for welded-line mounting.

The PS-500 line includes 10 units that offer measurement capabilities ranging from 0 to 50 psig through 0 to 5000 psig. Their signal output is 20 mV/V. Three PS-501 models take 0- to 15-psig, 3- to 15-psig, and 0- to 25-psig measurements and furnish a 5 mV/V output. All devices in both lines spec zero balance at $\pm 2\%$ FS. Outputs are fully temperature compensated over a -35 to +55°C operating range. Thermal shifts over the compensated range spec at 0.01%/°F FS and 0.01%/°F of reading for zero balance and sensitivity, respectively. Repeatability is better than 0.1%, and linearity

Manufacturers of pressure sensors and transducers

For more information on pressure sensors and transducers, circle the appropriate numbers on the Information Retrieval Service card or contact the following manufacturers directly.

Advanced Kinetics Inc
1231 Victoria
Costa Mesa, CA 92627
(714) 646-7165
Circle No 651

Ametek
Controls Div
860 Pennsylvania Blvd
Feasterville, PA 19047
(216) 355-6900
Circle No 652

Bailey Controls Co
29801 Euclid Ave
Wickliffe, OH 44092
(216) 943-5500
Circle No 653

Barber-Colman Co
1300 Rock St
Rockford, IL 61101
(815) 968-6833
Circle No 654

Barksdale Controls
Box 58843
Los Angeles, CA 90058
(213) 589-6181
Circle No 655

Beckman Instruments Inc
3900 River Rd
Schiller Park, IL 60176
(312) 671-3300
Circle No 656

Bell & Howell CEC
360 Sierra Madre Villa
Pasadena, CA 91016
(213) 796-9381
Circle No 657

BLH Electronics Inc
75 Shawmut Rd
Canton, MA 02021
(617) 821-2000
Circle No 658

Robert Bosch Corp
2800 S 25th Ave
Broadview, IL 60153
(312) 681-5000
Circle No 659

Bourns Instrument Div
6135 Magnolia
Riverside, CA 92502
(714) 684-1700
Circle No 660

Bristol Babcock Inc
40 Bristol St
Waterbury, CT 06708
(203) 575-3000
Circle No 661

Columbia Research Labs
MacDade & Bullens
Woodlyn, PA 19094
(215) 872-3900
Circle No 662

Computer Instrument Corp
100 Madison Ave
Hempstead, NY 11550
(516) 483-8200
Circle No 663

Conrac Corp
1600 S Mountain Ave
Duarte, CA 91010
(818) 359-9141
Circle No 664

Consolidated Controls Corp
15 Durant Ave
Bethel, CT 06801
(203) 743-6721
Circle No 665

Corning Glass Works
Corning, NY 14830
(607) 962-4444
Circle No 666

Data Instruments Inc
4 Hartwell Pl
Lexington, MA 02173
(617) 861-7450
Circle No 667

D-J Instruments Inc
18 Republic Rd
North Billerica, MA 01862
(617) 667-5301
Circle No 715

Dresser Industries
250 E Main St
Stratford, CT 06497
(203) 378-8281
Circle No 668

Druck Inc
Miry Brook Rd
Danbury, CT 06810
(203) 792-8981
Circle No 669

Dynisco
10 Oceana Way
Norwood, MA 02062
(617) 769-6600
Circle No 670

Endevco
30700 Rancho Viejo Rd
San Juan Capistrano, CA 92675
(714) 493-8181
Circle No 671

Entran Devices Inc
10 Washington Ave
Fairfield, NJ 07006
(201) 227-1002
Circle No 672

The Foxboro Co
38 Neponset Ave
Foxboro, MA 02035
(617) 543-8750
Circle No 673

Foxboro/ICT
1750 Junction Ave
San Jose, CA 95125
(408) 998-8720
Circle No 674

Furnas Electric Co
1000 McKee St
Batavia, IL 60510
(312) 879-6000
Circle No 675

Genisco Technology Corp
650 Easy St
Simi Valley, CA 93065
(805) 581-3985
Circle No 676

Gould Inc
Measurement Systems Div
2230 Statham Blvd
Oxnard, CA 93033
(805) 487-8511
Circle No 677

Gulton Industries
Servonic Div
1644 Whittier Ave
Costa Mesa, CA 92627
(714) 642-2400
Circle No 678

Hewlett-Packard Co
1507 Page Mill Rd
Palo Alto, CA 94302
Phone local office
Circle No 679

Honeywell Inc
2701 4th Ave
South Minneapolis, MN 55401
(612) 332-5200
Circle No 680

Honeywell Inc
Industrial Div
1100 Virginia
Fort Washington, PA 19034
(215) 643-1300
Circle No 681

IC Sensors Inc
430 Persian Dr
Sunnyvale, CA 94086
(408) 745-1814
Circle No 682

Kaman Instrumentation Corp
1500 Garden of the Gods Rd
Colorado Springs, CO 80933
(303) 599-1500
Circle No 683

Kavlico Corp
20869 Plummer St
Chatsworth, CA 91311
(213) 882-2400
Circle No 684

Kulite Semiconductor Products
1039 Hoyt Ave
Ridgefield, NJ 07657
(201) 945-3000
Circle No 685

Leeds & Northrup Corp
Sumneytown Pike
North Wales, PA 19454
(215) 643-2000
Circle No 686

Lion Precision Corp
11 Esquire Rd
Billerica, MA 01821
(617) 969-4710
Circle No 687

Measurement Systems Inc
523 West Ave
Norwalk, CT 06854
(203) 838-5561
Circle No 688

Micro Switch
Div of Honeywell
11 W Spring St
Freeport, IL 61032
(815) 235-6600
Circle No 689

Midwest Components Inc
1981 Port City Blvd
Muskegon, MI 49443
(616) 777-2602
Circle No 690

MKS Instruments Inc
445 Middlesex Tpk
Burlington, MA 01803
(617) 727-9255
Circle No 691

Motorola Semiconductor Products
Box 20912
Phoenix, AZ 85036
(602) 244-6900
Circle No 692

NovaSensor
2975 Bowers Ave
Santa Clara, CA 95050
(408) 988-4540
Circle No 693

Pacific Sensors Inc
4217 Ponderosa Ave
San Diego, CA 92123
(619) 277-5663
Circle No 716

Paine Instruments
2401 S Bayview St
Seattle, WA 98144
(206) 723-1705
Circle No 694

Panasonic
1 Panasonic Way
Secaucus, NJ 07094
(201) 348-7000
Circle No 695

PCB Piezotronics Inc
Box 33
Cheektowaga, NY 14043
(718) 684-0001
Circle No 696

Piezo Electric Products Inc
212 Durham Ave
Metuchen, NJ 08840
(201) 548-2800
Circle No 697

Robinson-Halpern Co
1 Apollo Rd
Plymouth Meeting, PA 19462
(215) 825-9200
Circle No 698

Schaevitz Engineering
Box 505
Camden, NJ 08101
(609) 662-8000
Circle No 717

Sensor Corp
Box 140
Scottsdale, PA 15683
(412) 887-4080
Circle No 699

Sensotec Inc
1200 Chesapeake Ave
Columbus, OH 43212
(614) 294-5436
Circle No 700

Sensym
1255 Reamwood Ave
Sunnyvale, CA 94086
(408) 744-1500
Circle No 701

Setra Systems Inc
45 Nagog Park
Acton, MA 01720
(617) 263-1400
Circle No 702

Taylor Instrument
95 Ames St
Rochester, NY 14692
(716) 235-5000
Circle No 703

Tektronix Inc
Box 500
Beaverton, OR 97005
(503) 644-0161
Circle No 704

Thermometrics Inc
808 Hwy 1
Edison, NJ 08817
(201) 287-2870
Circle No 705

Transducers Inc
14030 Bolsa Lane
Cerritos, CA 90701
(714) 739-1991
Circle No 706

Transducer Systems Inc
Box 341
Kulpsville, PA 19443
(215) 256-4611
Circle No 707

Transducers & Systems Inc
Twin Lakes Rd
North Branford, CT 06471
(203) 481-5721
Circle No 708

Transensory Devices Inc
44060 Old Warm Springs Blvd
Fremont, CA 94538
(415) 490-3333
Circle No 709

Unimeasure Inc
909 Williamson Loop
Grants Pass, OR 97526
(503) 476-1660
Circle No 710

Vernitron Corp
Vernitech Div
300 Marcus Blvd
Deer Park, NY 11729
(516) 586-5100
Circle No 711

Viatran Corp
300 Industrial Dr
Grand Island, NY 14072
(716) 773-1700
Circle No 712

West Coast Research Corp
1527 26th St
Santa Monica, CA 90404
(213) 478-8833
Circle No 713

Yellow Springs Instrument Co Inc
Box 279
Yellow Springs, OH 45387
(513) 767-7241
Circle No 714

Bonded, foil transducers are made from metallic foil specially configured to be sensitive to strain in only one direction.

(including hysteresis) is better than 0.5% FS. Excitation is from a standard 5V dc regulated source.

Long life and shock resistance

The minimum service life of the devices is 160 million cycles. All units spec a 50g shock and vibration resistance. They will withstand overloads as high as 150% FS without zero shift and burst pressures greater than five times full scale or 15,000 psi, whichever is less.

West Coast Research uses a bonded strain gauge (foil or silicon) and a stainless-steel diaphragm as the sensing element in its Model 193 miniature pressure transducer. Housed in a package measuring $\frac{5}{8} \times 1$ or $\frac{3}{4} \times \frac{7}{8}$ in. and weighing only 2 oz, the device is suited to applications in which small size and low mass are important design considerations. The transducers will stand up to corrosive and oxidizing environments, and you can expose them to temperatures as high as 450°F.

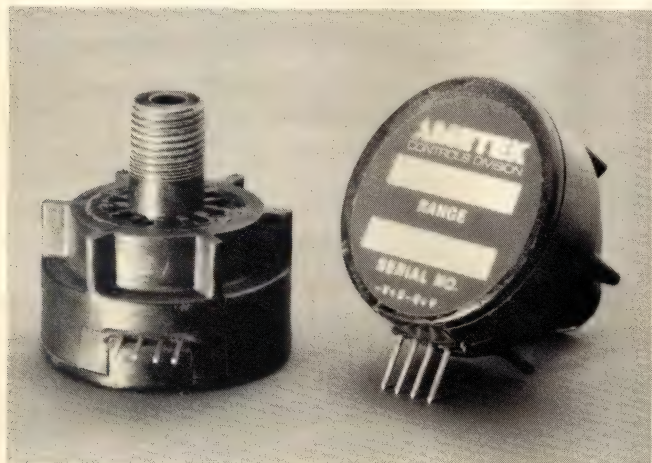
Model 193 versions handle six measurement ranges: 0 to 15, 0 to 30, 0 to 50, 0 to 100, 0 to 1000, and 0 to 3000 psig. The device costs \$430. Over the temperature-compensated range of 0 to 200°F, linearity and repeatability both spec at 0.5% FS. Maximum zero drift equals 0.01% FS/°F. Standard versions employ a foil-type strain gauge, and output sensitivity equals 2 mV/V (for 1 to 10V excitation). Use of a silicon strain gauge increases the sensitivity figure to 100 mV/V for the same excitation range. A third transducer version includes an integral instrumentation amplifier that provides a 5V FS output.

Standard versions of the transducers employ stainless-steel packaging; high-temperature units use Inconel or Hastalloy materials. The pressure connection is via a $\frac{1}{8}$ -in. NPT or AN port. A Teflon-coated, 4-conductor pigtail or a Teflon-wrapped shielded cable serves as the electrical input (a case-mounted connector is available as an option). Because the transducer is light, you use the threaded male pressure fittings for mechanical mounting. Screw-type, case-mounted brackets are also available.

Measurement range to 50,000 psig

Dynisco's Model STD (standard temperature) and STD-H (high temperature) transducers measure high pressure levels. Both models are available in five full-scale measurement ranges; 0 to 5000, 0 to 10,000, 0 to 20,000, 0 to 30,000 and 0 to 50,000 psig. They feature all-stainless-steel construction and incorporate a 1-piece sensing tube that employs bonded strain gauges configured in a Wheatstone bridge. The sensing ele-

Depending on the material used for the strain-gauge elements, a 10V excitation can produce full-scale outputs of 20 to 500 mV.



A laser-trimmed hybrid circuit determines the nominal output and provides temperature compensation over a -25 to $+75^{\circ}\text{C}$ range in the IPT transducers from Ametek. These parts take gauge, absolute, and differential pressure measurements.

ment has no moving parts and minimal deflection, resulting in a rugged transducer capable of withstanding severe shock and vibration. You can use standard production units with any pressure medium that won't corrode 410 or 15-5 PH stainless steel.

Accuracy—including nonlinearity, hysteresis, and repeatability—is within $\pm 0.05\%$ FS for the STD and $\pm 0.7\%$ for the STD-H. Respective repeatability figures spec at $\pm 0.05\%$ and $\pm 0.1\%$. Full-scale output at recommended excitation (6V ac/dc) is $6\text{ mV} \pm 0.25\%$, and sensitivity measures $1\text{ mV/V} \pm 0.25\%$. The functional operating temperature ranges are -35 to $+65^{\circ}\text{C}$ and -35 to $+252^{\circ}\text{C}$ for the STD and STD-H, respectively; the compensated ranges are -10 to $+46^{\circ}\text{C}$ and -10 to $+218^{\circ}\text{C}$. The STD part costs \$1025 to \$1325; the STD-H part costs \$1125 to \$1425.

Techniques that deposit the resistor network onto the diaphragm result in sensors that are more stable than those employing bonding techniques. Devices using the deposition techniques have good zero and full-scale sensitivity stability and good long-term stability.

D-J Instruments manufactures its type-CA, -CS, and -CC transducers with what it calls a "transbar" technology. The units employ a strain-gauge bridge deposited, via thick-film technology, on a ceramic diaphragm. The diaphragm is fused onto a ceramic baseplate by means of a high-temperature glass seal. The sensors are zero balanced; the trimming of a thick-film resistor network deposited on the capsules' back plate adjusts the devices' span figures.

The transbar transducers measure differential or ab-

solute pressures. The \$15 CS is the basic sensor, and the \$16.46 CA is the zero-balanced version (prices are for quantities of 10,000). Nine models cover the measurement ranges 1.5 to 10 psi through 600 to 3000 psi. Typical sensitivity ranges from 0.41 to 0.0028 mV/V/psi, and the total error band measures 0.5 to 0.2% FS. The maximum excitation voltage specs at 30V, and the operating temperature range is -65 to $+260^{\circ}\text{F}$. Thermal zero drift equals $0.003\text{ mV/V}/^{\circ}\text{F}$, and thermal sensitivity shift is $0.03\%/^{\circ}\text{F}$ max.

The \$64.50 type-CC sensors accommodate both static and dynamic absolute or gauge pressure measurements from 7.5 to 3000 psi. Total error band specs at 0.5 to 0.3% of a 4V FS. Operation spans -15 to $+185^{\circ}\text{F}$. Thermal zero drift (from 32 to 140°F) measures $\pm 1\%$ FS max, and thermal sensitivity shift equals $\pm 0.006\%/^{\circ}\text{F}$.

Sputtering borrowed from IC makers

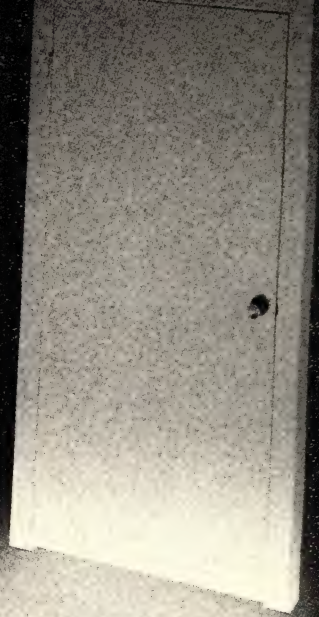
Gulton Industries' GMS 110 pellicloidal sensors are designed to withstand extremely hostile environments. A thin-film strain-gauge Wheatstone bridge using precious-metal resistive elements is deposited on a silicon pressure diaphragm. The sensing elements and interconnecting circuitry are deposited using a sputtering technique similar to that used by semiconductor manufacturers. The units feature all-welded construction (where applicable) and hermetic seals. There are no moving parts other than the diaphragm.

The pellicloidal sensors accommodate any pressure medium that's compatible with stainless steel and silicon. The devices take pressure measurements in two ranges: 15 to 100 psi and 100 to 5000 psi. High-pressure-range devices employ a single crystal sapphire in place of the single crystal silicon bridge. Nonlinearity is less than $\pm 0.3\%$ FS. Zero balance specs at $\pm 2\%$ FS, and sensitivity equals $2.5\text{ mV/V} \pm 1\%$ FS (assuming a typical excitation voltage of 8 to 12V).

Proof and burst pressures spec at 150 and 200% FS. Hysteresis and nonrepeatability equal $\pm 0.05\%$ FS. Operation spans -65 to $+250^{\circ}\text{F}$. Zero shift and sensitivity shifts measure 0.005% FS/ $^{\circ}\text{F}$. Nominal input and output impedances spec at 1 k Ω , and current drain equals 10 mA (for a 10V dc excitation). A basic unit costs \$695, but the parts generally form the basis of custom designs.

Non-strain-gauge transducers, though not subject to radical technological changes, still abound and offer advantages of their own. Transformer-based devices, for example, have long operational lives and furnish

IF YOU THINK MEMORIES IS A
CLOSED MARKET, THINK AGAIN.



To handle harsh industrial environments, some transducer designs employ a flexible stainless-steel diaphragm.



Employing variable-reluctance sensing technology, PT Series transducers from Columbia Research span a 10- to 150-psi range for gauge, absolute, or differential measurements. They feature accuracies within 1% FS.



Developed to handle corrosive media, the Mediamate from Data Instruments measures pressures ranging to 5000 psig and features 1% FS accuracies.



For measuring differential pressures from 0 to 250 psi in seven ranges, Model 33 sensors from IC Sensors feature integral laser-trimmed resistors to provide temperature compensation over 0 to 50°C.

excellent resolution. In these parts, a transformer coil serves the sensing element. The transducers are not affected by mechanical overload, so they're very reliable. They react well to vibration and are suited to harsh environments.

One example of transformer-based transducers is the P-3000 Series from Schaevitz Engineering. These devices measure low to moderate pressures—gauge, absolute, or differential—in a variety of noncorrosive liquids or gases. The series includes dc/dc transducers, 4- to 20-mA 2-wire transmitters, and a pressure-to-current converter.

The pressure-sensing element is in an all-welded Ni-Span C capsule. Pressure-related deflection is measured by an LVDT displacement sensor whose core is coupled to the capsule. The LVDT produces an electrical output that's directly proportional to core motion, which is, in turn, proportional to the pressure applied to the capsule.

Transformer-based unit has 5V output

The P-3061 transducers take measurements over a 0.1- to 100-psi range. They operate from a 10 to 32V unregulated source and provide a 0 to 5V dc output. Output change with variation in input voltage is less than 0.1%. Combined static error (nonlinearity, nonrepeatability, and hysteresis) is less than 5% FS. Zero-set and span-set ranges spec at $\pm 10\%$. The overall operating range is -40 to $+80^\circ\text{C}$; the compensated range is -5 to $+65^\circ\text{C}$. Thermal zero and span shifts spec at

0.02% FS/ $^\circ\text{C}$. Prices range from \$275.60 to \$325.20, with quantity discounts available.

All electronic circuitry needed to operate the LVDT is on a pc board housed within a separate compartment of the transducer case. The circuitry provides LVDT excitation as well as signal amplification. Input power connections are diode-protected against damage from reverse polarity. Controls mounted on the circuit board set the transducer's zero and span; you can access these controls without removing the transducer's protective cover. All connections are brought out through a shielded cable.

Columbia Research is another company that uses transformer coils in its transducers. Each PT Series unit's sensing system employs an LVDT in a capsule. They operate from an ac source (5V rms at 3 kHz) and include no signal-conditioning circuitry. Because the movable core does not make physical contact with the transformer coils, transducers of this type are less likely to suffer from wear and contamination problems.

PT Series sensors cover a 10- to 150-psi measurement range and come in versions for gauge, absolute, and differential measurements. The devices will withstand two times the FS pressure range. Typical FS output (into a 5-M Ω load) equals 1V rms. Zero balance equals $\pm 0.5\%$ FS, and nonlinearity and hysteresis measure $\pm 0.75\%$ FS. Repeatability specs at $\pm 0.15\%$.

The overall operating range spans -40 to $+250^\circ\text{F}$; compensation is provided over -40 to $+200^\circ\text{F}$. Sensitivity and zero-balance changes with temperature (over

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KM41257	256K		120/150	NIBBLE	DIP, PLCC, ZIP
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KM2817A	16K	2K x 8	300/350	R/B	DIP
KM2864A*	64K	8K x 8	250/300	R/B	DIP, PLCC
SRAMs					
KM6264*	64K	8K x 8	100/120/150		DIP/SOP

*Qual samples available Q2. Production quantities in Q3.



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SAMSUNG SAYS SO.

Nonsilicon sensors abound, and many serve in applications that require output levels not yet within the range of the silicon devices.

the compensated range) equal $\pm 0.015\%/^{\circ}\text{F}$ and $\pm 0.02\% \text{ FS}/^{\circ}\text{F}$, respectively. A 10-psig device costs \$295 (11).

Two more transducer types—piezoelectric and variable-capacitance devices—remain popular. Both types feature good accuracy. Piezoelectric devices are very small and provide the best frequency response of any transducer that measures changes in pressure.

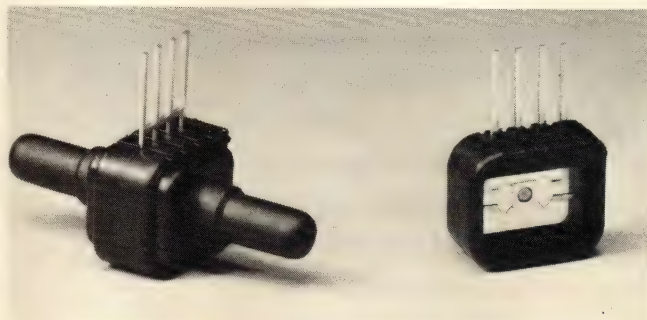
General-purpose Series 111A20 quartz minigauges from PCB Piezotronics measure dynamic and short-term static pressures from a vacuum to 10,000 psi. The piezoelectric sensing system in these devices contains a rigid, multiplate, compression-mode quartz element, with an integral compensating accelerometer to reduce motion sensitivity. The units measure transient or repetitive phenomena, relative to the initial or average pressure level, over wide amplitude and frequency ranges, and under adverse environmental conditions.

When connected to a power unit, 111A20 self-amplifying transducers generate a high-level, low-impedance analog output signal that's compatible with most read-out instruments. PCB offers a simple unit that powers the transducer over the signal lead (coaxial or 2-wire), eliminates bias on the output, and monitors normal or faulty operation.

Measurement capability, for a standard 5V output, ranges to 5000 psi. The devices' useful overrange (10V output) and maximum pressures spec at 10,000 and



High pressure and high temperature measurements are within the range of Dynisco's Model STD and STD-H transducers. Both handle pressure ranges to 50,000 psi, and the STD-H will respond to temperatures of 486°F.



Most types of media can be in direct contact with either side of the sensing element in Micro Switch's Model 16 PCD transducer.

15,000 psi, respectively. Resolution equals 0.1 psi, and sensitivity measures 1 mV/psi. The output impedance equals 100 Ω , and acceleration sensitivity specs at 0.002 psig. The temperature range spans -100 to $+275^{\circ}\text{F}$, and the TC equals $0.03\%/^{\circ}\text{F}$. Prices start at \$330.

Vary capacitance to produce output

In variable-capacitance devices, pressure moves a diaphragm, and the change in position relative to a second element produces a capacitance change that yields the output. Units in the 200 Series of electronic nanometers from MKS Instruments employ variable-capacitance technology. The systems require three major components to convert pressure to a usable dc voltage output: a sensor, a signal conditioner, and a power supply.

Model 220B, -221A, -222B, -224, -230, and -227A transducers each contain a tensioned metal diaphragm. One side of the diaphragm is exposed to the gas being monitored; the other side contains an electrode assembly located in a factory-sealed reference cavity maintained at a high vacuum level by an integral chemical getter system. The diaphragm deflects in response to changes in absolute pressure (independent of the measured gas composition), causing a capacitance change between the diaphragm and the adjacent electrode assembly.

The signal conditioner, available in all units, contains a fixed-frequency oscillator, an amplifier, a demodulator, and calibration circuitry. The signal conditioner takes the ac voltage generated by the capacitance change, amplifies it, demodulates it, and converts it to a dc voltage that's linear with pressure and calibrated against a pressure standard. The maximum output is 10V dc.

The 220B transducer contains the required sensor, signal conditioner, and power supply. You only need to



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*Patent Pending

add a display unit (available from the manufacturer) for a direct pressure readout. The transducer features de proportional control to maintain the sensor at $45 \pm 0.1\%$ °C. The basic 220B unit costs \$1225.

The 221A, 222B, and 227A devices (\$685, \$575, and \$995, respectively) include only the sensor and signal conditioner. To develop a total system, users must add a power supply and a readout device. Model 224 (\$690) includes the sensor, the signal conditioner, two separate setpoints, and two LED below-setpoint indicators. Again, you'll have to add a supply and readout device to obtain a complete pressure-measurement system. Model 230 (\$575) provides a 4- to 20-mA output and is similar to the 222B unit.

System performance varies with the choice of transducer. FS pressure measurement ranges from 1 to 10,000 torr, and accuracy figures (including effects of hysteresis, nonlinearity, and nonrepeatability) range from 0.15 to 1% of reading. Operating ranges are 0 to 50°C for the 222B, 224, and 230 transducers, 5 to 40°C for the 220B, and 15 to 40°C for the 227A. Overpressure limit equals 120% FS or 20 psia, whichever is greater. RFI suppression is standard on all models. **EDN**

Acknowledgment

EDN would like to thank Roger Grace of Roger Grace Associates (San Francisco, CA) for his invaluable assistance in supplying background information for this article.

Article Interest Quotient (Circle One)
High 470 Medium 471 Low 472

If you think of LVDT's when you think of Schaevitz,



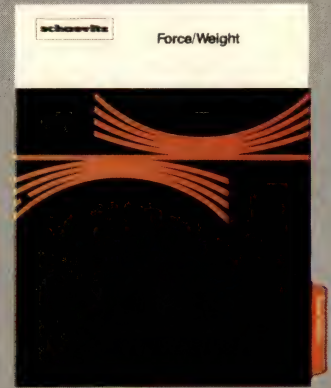
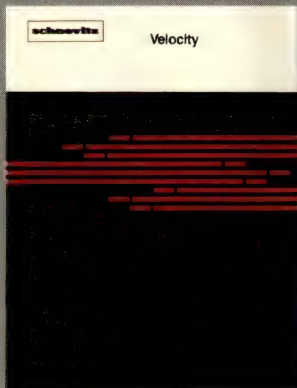
think again.

Schaevitz incorporates force balance servo technology in its high accuracy, high reliability accelerometers and rate sensors. For a catalog of standard products, circle reader service number **244**

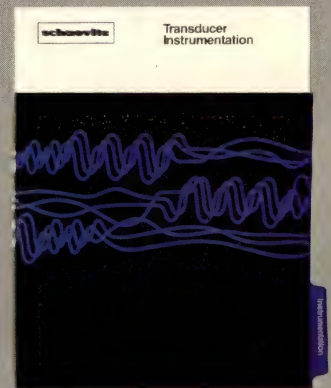
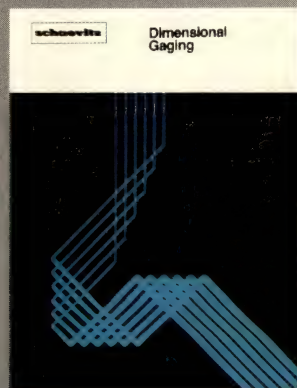
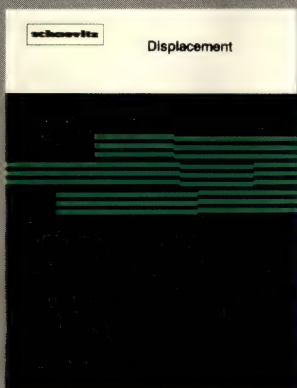
Schaevitz offers self-generating linear velocity transducers in several sizes and ranges for a variety of dynamic motion measurements. For a complete catalog, circle reader service number **245**

Schaevitz utilizes several sensing technologies to produce a broad line of products for measuring absolute, gage, and differential pressures. For a selection guide, circle reader service number **246**

Schaevitz' LVDT-based load cells permit small force level measurements that are impractical utilizing other technologies. For a catalogue of these unique sensors, circle reader service number **247**



And again.



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*QMOS is RCA high speed CMOS logic.

Alternate sources: Philips N.V. and Signetics.

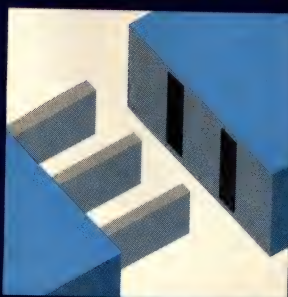


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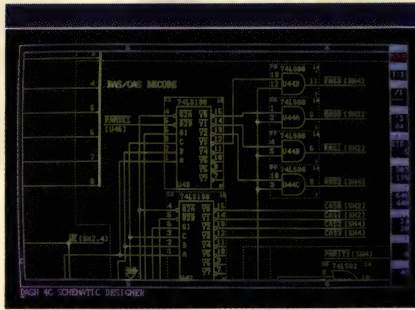
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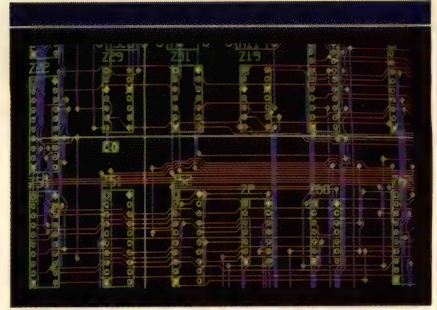
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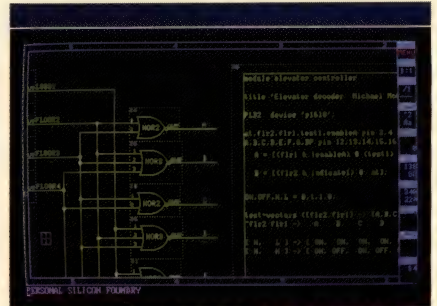
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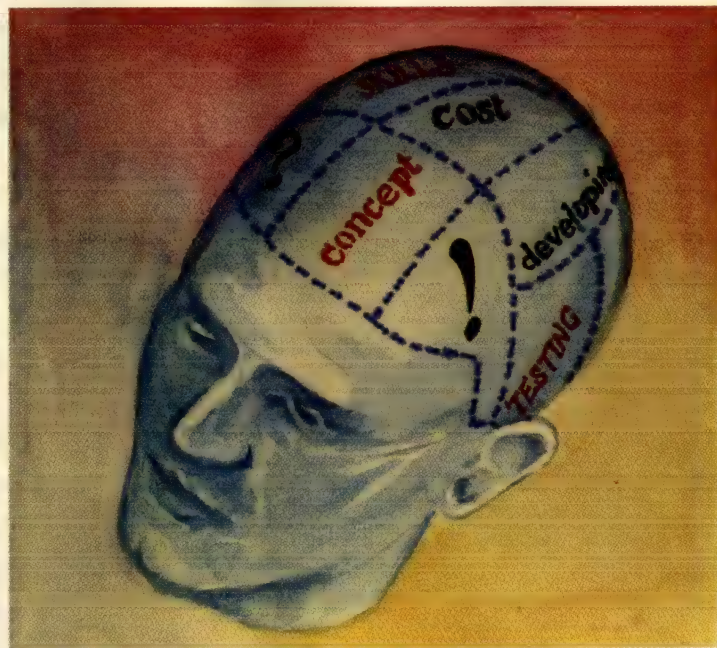
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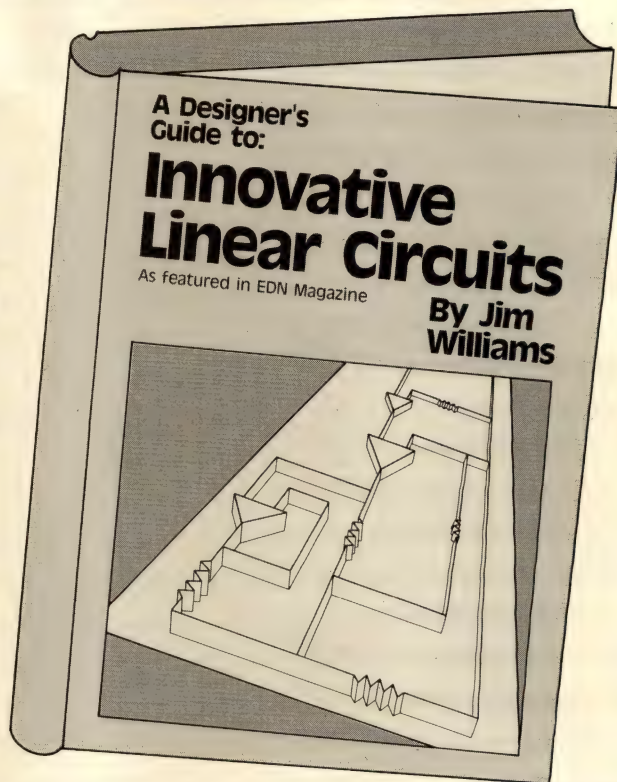
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Electro/86

Electro/86 and its companion show, Mini/Micro Northeast, will highlight a slew of high-performance board-level products as well as new support ICs for 32-bit μ Ps. The professional programs will include introductory tutorials and detailed technical sessions.

Charles H Small, Associate Editor

Electro/86 and Mini/Micro Northeast, scheduled for May 13 to 15 at the Boston, MA, Bayside Exposition Center and the World Trade Center, will provide the opportunity for an expected 50,000 attendees to learn about new and upcoming products. Furthermore, registrants will have the chance to sharpen their professional skills at any of the 54 professional-program technical sessions.

Although it's no secret that the electronics sector of the economy has not fared particularly well during the past year, Electro and Mini/Micro may foreshadow better times to come. Booth space at both exhibitions has been sold out since January. Most members of the conference committees hesitate to say that the sold-out space heralds the beginning of an improved economy, but the positive indications are there for trend watchers to consider.

At Electro, you can expect new-product exhibitions in the areas of CMOS ICs, digital-signal-processing

(DSP) chips, defense-related products, and instrumentation to be particularly prevalent. The technology-driven avalanche of CMOS product introductions continues, unaffected by the state of the economy, simply because CMOS-based ICs are superior to other technologies. Similarly, DSP chips are at the center of the explosion in computerized communications, and the industry is experiencing strong demand for faster multiplier/accumulators. Military products are benefiting from increased defense budgets. Finally, instrument makers have been prudently using the lull in sales of capital equipment to engage in advanced development of new generations of oscilloscopes, logic analyzers,

digitizers, microwave and RF equipment, systems instruments (and the calibration/laboratory instruments to calibrate the systems instruments automatically), and protocol and bus analyzers.

Bus and board-related products on view

By far the greatest number of Mini/Micro exhibitors will stress bus products—Multibus I and II, VME Bus, and STD Bus—and related board-level products. Exhibitors will concentrate on five major areas: single-board computers, high-performance disk controllers, analog and digital I/O boards, multiplexers, and signal-conditioning/processing boards. Naturally, you'll need a

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		ROOM A	ROOM B	ROOM C
TUESDAY MAY 13	9:00 AM TO 11:00 AM	1 CHOOSING A DESIGN CENTER FOR YOUR CUSTOM/SEMICUSTOM SYSTEM DESIGN	2 THE STRATEGIC DEFENSE INITIATIVE IN PERSPECTIVE	3 PERSPECTIVES ON SURFACE MOUNTING IN THE UNITED STATES
	12:30 PM TO 2:30 PM	4 ADDING VLSI FUNCTIONS TO STANDARD CELL LIBRARIES FOR APPLICATION-SPECIFIC IC DESIGN	5 ENGINEERING EDUCATION—WHAT'S WRONG, AND WHAT NEEDS TO BE DONE TO CORRECT IT?	6 HIGH-PERFORMANCE INTERCONNECT TECHNOLOGY: TAPE AUTOMATED BONDING (TAB)
	3:30 PM TO 5:30 PM	7 ASIC: CHOICES FOR A NEW GENERATION	8 SIGNAL-FLOW ANALYSIS*	9 SURFACE MOUNTING WITH INTEGRATED CIRCUITS
WEDNESDAY MAY 14	9:00 AM TO 11:00 AM	10 RECENT ADVANCES IN DISCRETE MOS-GATED POWER STRUCTURES	11 VLSI DESIGN WITH SILICON COMPILERS	12 BEYOND MEMORY—DIVERSE APPLICATIONS OF ELECTRICALLY ERASABLE MEMORY TECHNOLOGY
	12:30 PM TO 2:30 PM	13 POWER-IC AND SMART-POWER-IC TECHNOLOGY	14 AN OVERVIEW OF OFFSHORE OPPORTUNITIES FROM FOUR WORLD AREAS	15 THE FASTEST SILICON TODAY—BIPOLEAR ECL
	3:30 PM TO 5:30 PM	16 HOW BRUSHLESS DC MOTORS ARE COMING OF AGE IN THE WORLD TODAY	17 GOING PUBLIC	18 RECENT DEVELOPMENTS IN LOGIC-ARRAY TECHNOLOGY
THURSDAY MAY 15	9:00 AM TO 11:00 AM	19 GROUNDING AND SHIELDING ELECTRONIC INSTRUMENTATION*	20 COMMUNICATION FUNDAMENTALS IN FLEXIBLE AUTOMATION*	21 SYSTEM IMPLICATIONS AND APPLICATIONS RESULTING FROM RECENT DISK-CONTROLLER-IC TECHNOLOGY ADVANCES
	12:30 PM TO 2:30 PM	22 THE WHYS AND WHEREFORES OF THE TRANSFER OF TECHNOLOGY	23 THE NEXT GENERATION OF PROGRAMMABLE LOGIC DEVICES WILL LAUNCH A NEW ERA IN SYSTEM DESIGN—I	24 FAULT-SIMULATION TECHNIQUES AND TESTABILITY ANALYSIS
	3:30 PM TO 5:30 PM	25 RADAR—LATEST DEVELOPMENTS AND FUTURE TRENDS*	26 THE NEXT GENERATION OF PROGRAMMABLE LOGIC DEVICES WILL LAUNCH A NEW ERA IN SYSTEM DESIGN—II	27 NONSTANDARD ATMOSPHERIC EFFECTS ON RADAR- AND COMMUNICATION-SYSTEMS PERFORMANCE

*MINITUTORIALS

MINI/MICRO NORTHEAST-86 PROFESSIONAL PROGRAM WORLD TRADE CENTER, BOSTON, MA

		ROOM A1	ROOM A2	ROOM A3
TUESDAY MAY 13	9:00 AM TO 11:00 AM	1 INTEGRATED SERVICES DIGITAL NETWORKS*	2 MICRO-TO-MAINFRAME COMPUTER-AIDED DESIGN	3 THE CMOS REVOLUTION HITS BIT-SLICE MICROPROCESSORS
	12:30 PM TO 2:30 PM	4 SATELLITE DATA COMMUNICATION*	5 USING THE PC FOR LOGIC DESIGN	6 ADVANCED APPLICATIONS USING NEW-GENERATION BIT-SLICE PROCESSORS
	3:30 PM TO 5:30 PM	7 TELECOMMUNICATIONS: INTERFACING TO THE NETWORK	8 ENHANCING YOUR PC ENGINEERING WORKSTATIONS	9 DESKTOP COMPUTERS IN PROCESS CONTROL*
WEDNESDAY MAY 14	9:00 AM TO 11:00 AM	10 INTEGRATING ISDN AND LAN SERVICES IN THE OFFICE ENVIRONMENT	11 PRODUCT STANDARDS: A GROWING CONCERN*	12 BUS WARS—THE 32-BIT FRONTIER
	12:30 PM TO 2:30 PM	13 OPTICAL COMMUNICATION	14 SMARTER CHIPS FOR BETTER DESIGN	15 32-BIT HIGH-END MICROPROCESSORS
	3:30 PM TO 5:30 PM	16 ENGINEERING MANAGEMENT TECHNIQUES FOR THE FUTURE	17 NONIMPACT PRINTING FOR INSTRUMENTATION, SCIENTIFIC, AND ENGINEERING APPLICATIONS	18 PROGRAMMABLE SINGLE-CHIP DIGITAL SIGNAL PROCESSORS
THURSDAY MAY 15	9:00 AM TO 11:00 AM	19 ALTERNATIVE METHODS FOR MICROPROCESSOR SOFTWARE GENERATION	20 PC-BASED CAE—IS IT THE TOTAL SOLUTION?	21 TOOLS FOR MIL-STD-1758A SOFTWARE DEVELOPMENT
	12:30 PM TO 2:30 PM	22 SOFTWARE DESIGN TOOLS FOR REAL-TIME SYSTEMS	23 COMPUTER-INTEGRATED TEST—CLOSING THE QUALITY FEEDBACK LOOP	24 FUTURE TECHNOLOGY OF SMART CARDS IS AVAILABLE TODAY
	3:30 PM TO 5:30 PM	25 USING UNIX IN A REAL-TIME ENVIRONMENT	26 SYSTEM AND APPLICATION IMPLICATIONS FROM FAST STATIC-RAM ADVANCES	27 NEW APPLICATIONS FOR LOW-COST MICROCONTROLLERS

*MINITUTORIALS

place to put all these boards, so other exhibitors will show packaging systems, card cages, power supplies, and backplanes.

Some segments of the electronics industry do not view Electro or Mini/Micro as the place for significant introductions, and so you can expect Comdex to siphon off most of the blockbuster engineering-software and superminicomputer introductions. Likewise, CICC (Custom IC Conference) will be the site where many of this year's engineering-workstation and ASIC products will first see the light of day.

In addition to seeing and comparing the many products on display at Electro and Mini/Micro, attendees will be able to participate in 54 professional-program technical sessions. These sessions will cover a wide variety of applications-oriented topics of interest to engineers. Of special interest will be eight minitutorials

designed to acquaint engineers with the basics of a particular area of electrical engineering outside their own field. Some minitutorials will cover basic electronics design principles as they apply to today's engineering practices, and others will cover topics from a systems' point of view.

Also, several bus users' groups will hold meetings during Mini/Micro. The controversy between established buses like Multibus I or the STD Bus and the newer 32-bit VME Bus or Multibus II products will raise the interest level at both the exhibits of the bus products and the meetings of the proponents for individual buses.

EDN

Article Interest Quotient (Circle One)
High 473 Medium 474 Low 475



Seventy-two hours ago you didn't know you needed an emulator.

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included new high performance cross-assemblers.

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Our 16-bit emulator keeps state-of-the-art system debug from turning into a state of siege.

It takes a powerful emulator, not promises, to get a bug-free product to market quickly. Applied Microsystems' 16-bit ES emulator runs identically to the processor in your target system. At the full-rated clock speed.

Our unique Event Monitor System lets you precisely control and monitor emulation flow with a combination of address, data, status, pass counter, and logic state events. You can quickly sort through thousands of bytes of code to find the small sections where bugs are embedded. Once discovered, use our resident symbolic debug to quickly patch in new code and test it in real time.

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Validate™, our new family of enhanced development environments, offers you the combined power of integrated hardware and software tools. Centered around a true source-level debugger, Validate works with "C" and Pascal on UNIX and VMS systems.

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8-BIT: 8080, 8048 family, 8085, 8088, 80188, Z80, NSC-800, 6800 family, 6809, 6809E, 68008, V20

16-BIT: 68000, 68010, 8086, 80186, Z800X, V30

32-BIT: 68020

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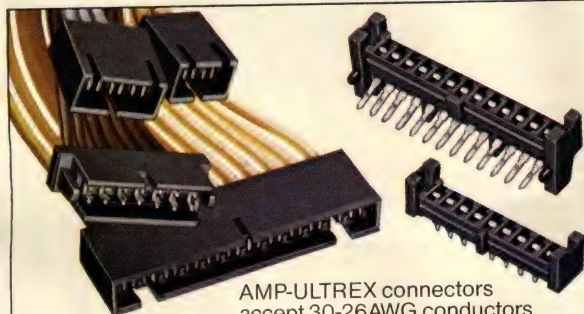
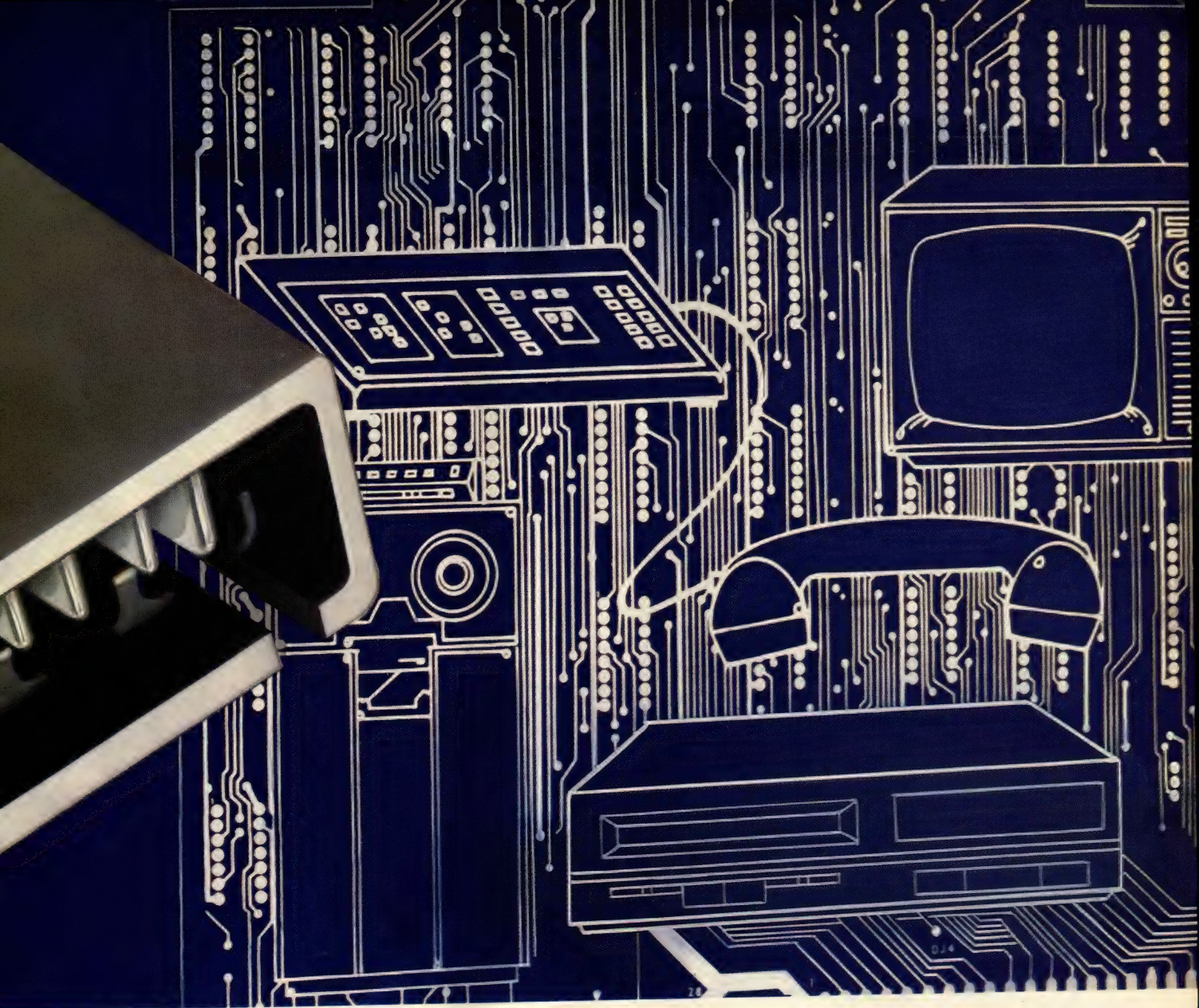
Unique contact design is your key to savings in the below-.100" centerline realm. AMP-ULTREX

connectors offer cost-effective tin-plated phosphor bronze contacts. With exclusive stored-energy mating for unparalleled long-term reliability.

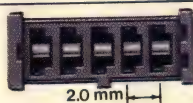
Stored energy is provided in the spring header contact, with the receptacle side providing contact wiping and two-point contact with each spring. Result: lasting performance.

You'll find other features noteworthy, too. Built in keying and polarization, with very positive detent locking for high vibration resistance. Bottom-sealed vertical and horizontal headers offer protection against solder wicking and flux contamination, and anti-overstress design prevents post deformation.

The time to find out more? Now. Or at least before you design your next board.



AMP-ULTREX connectors accept 30-26AWG conductors, UL Recognized.



2.0 mm

2mm system offers crimp-snap termination, hand or machine applied.

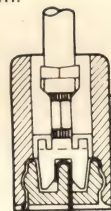


2.5 mm

2.50mm system available with crimp-snap or mass-termination capability.



Exclusive contact design provides stored-energy connection in an inexpensive tin-plate system.



Receptacle Housing

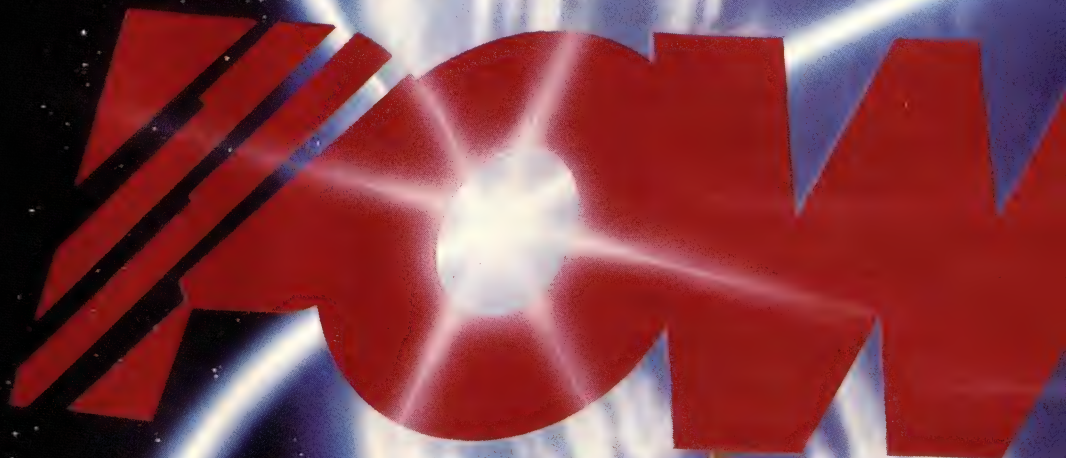
Positive detent lock

Solder Post

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CIRCLE NO 80

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DMM in its class. Like the 8842A, it's simple to operate. It gives you long-term reliability. And it delivers high productivity with a low overall cost of ownership.

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0.16% basic ac accuracy (1 Yr.)	0.08% basic ac accuracy (1 Yr.)
0.013% basic ohms accuracy (1 Yr.)	0.008% basic ohms accuracy (1 Yr.)
Resolution to 1μV dc, 10μA dc, 1mΩ	Resolution to 100nV dc, 1μA dc, 100μΩ
One-year specifications and warranty	Two-year specifications and warranty
8840A \$760	8842A \$995
8840A-05 IEEE-488 Interface \$150	8842A-05 IEEE-488 Interface \$150
8840A-09 TRMS AC option \$185	8842A-09 TRMS AC option \$250

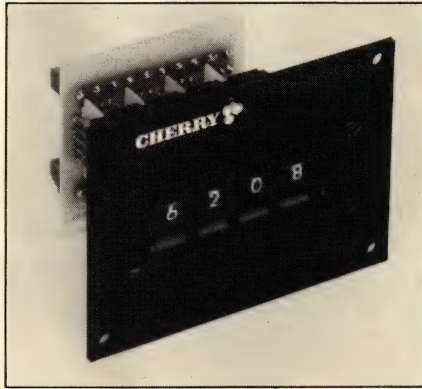


* Patent pending
IN THE U.S. AND NON-EUROPEAN COUNTRIES: John Fluke Mfg. Co., Inc., P.O. Box C9090, M/S 250C, Everett, WA 98206. Sales: (206) 356-5400, Other: (206) 347-6100.
EUROPEAN HEADQUARTERS: Fluke (Holland) B.V., P.O. Box 2269, 5600 CG Eindhoven, The Netherlands. (040) 458045, TLX: 51846.
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Programmable-controller thumbwheel switch comes with 2-, 3-, or 4-digit readouts

TH Series modular BCD thumbwheel switch assemblies are available with outputs of two, three, or four digits. A set of comb-like wiping contacts, rotated by the thumbwheel, connects predetermined combinations of traces on a stationary pc board. The traces are brought out to screw terminals that serve as electrical input and output lines.

Two internal connection types are available: bussed, in which the BCD 1-2-4-8 lines of all switches are connected together, but each switch has a separate common line; and unbussed, in which all lines of each



switch are separate. The switches come in positive-logic (one true) or negative-logic (zero true) versions.

An integral bezel allows you to

mount the switches through a rectangular panel cutout with four screws. The switches are sealed against moderate amounts of dust and dirt by a clear plastic window covering the dial-character openings. Current-carrying capacity is 125 mA max at 28V dc, and mechanical life is greater than 1 million detent operations for a resistive load of 10 mA at 5V dc (25°C). \$44.95 to \$65.

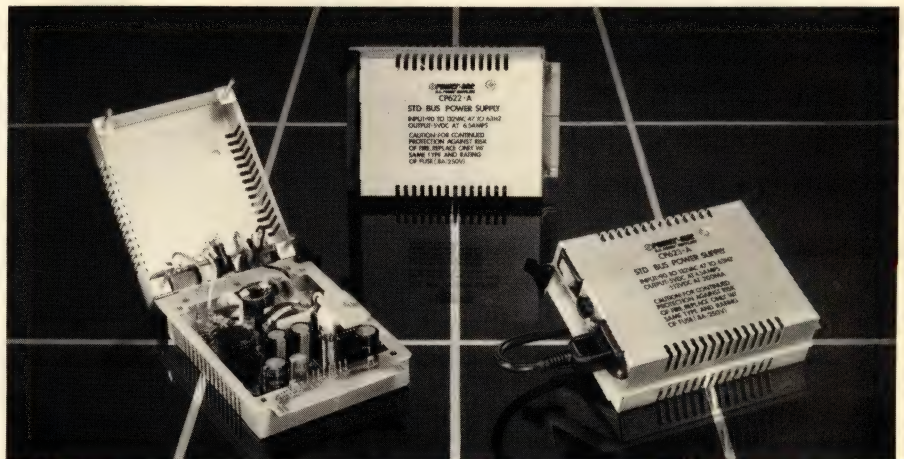
Cherry Electrical Products Corp., 3600 Sunset Ave., Waukegan, IL 60087. Phone (312) 360-3500. Booth No 1416.

Circle No 581

Rack-mount or free-standing supplies deliver 74W for STD Bus applications

The Bus-Power Series is a line of three power supplies for applications that require as much as 74W of dc power in compact, STD Bus-compatible packages. The three models are adequate to power most STD Bus applications: The 32.5W BP622A provides 6.5A at 5V, the 27.3W BP623-A provides 4.5A at 5V and 0.2A at $\pm 12V$, and the 74W BP624-A provides 10A at 5V and 1A at $\pm 12V$. All three models are available as free-standing, rack-mountable, or surface-mounting packages and are UL recognized and CSA certified. The vendor furnishes connectors and mounting facilities with each power supply.

Standard inputs are 90 to 132V ac, 47 to 63 Hz, single-phase; 400-Hz versions are also available. Holdup time is 20 msec min at the full-rated load and nominal input voltage; holdup time increases to 40 msec at a 50% load. Maximum output noise



and ripple are 0.3% rms, 1% p-p max. Recovery time of the main 5V output is typically 300 μ sec to within 1% of the initial voltage after a 50% to 100% load change. The maximum excursion from the initial voltage is 3%.

Convection cooling is adequate where air flow is unrestricted; forced cooling is recommended for

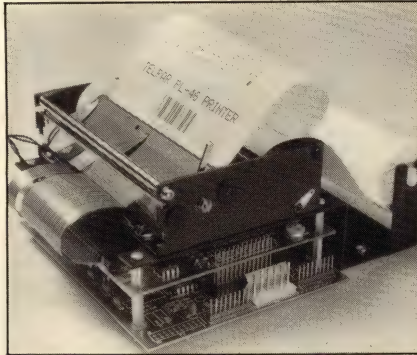
confined areas. The operating temperature range is 0 to 50°C at the full-rated output power. BP622-A, \$210; BP623-A, \$230; BP624-A, \$245.

Power-One Inc., 751 Daily Dr., Camarillo, CA 93010. Phone (805) 388-2839. TLX 311492. Booth No 2351.

Circle No 584

Thermal printer offers alphanumeric, bit-image, and bar-code printing

The PL46E is an 46-column thermal printer with three graphics modes: dot-addressable, bit-image, and line-segmenting. In character mode, the printer can generate double-height or double-width (or both) ASCII characters in normal or reverse print; you can also invert characters or print along the X or Y axes of a graph. You can mix character and graphics modes in the same line. In bar-code mode, the printer can generate UPC, code 39, and 2-of-5 codes. The printer accommodates roll paper as wide as 3 in. Standard printing speed is 2.1 lps



(97 cps); speeds as high as 4 lps are available as an option.

The printer comes with a 1k-byte buffer (a 7k-byte buffer is available

as an option). Both RS-232C serial and Centronics parallel interfaces are standard; 20-mA current loop and RS-422 interfaces are also available. The serial interface handles data rates as high as 19.2k bps, with switch-selectable ETX/ACK or X-On/X-Off handshaking. Black-dot sensing (for coupon, label, and ticket printing) is a standard feature. A real-time clock is optional. \$395 (100).

Telpar Inc, Box 796, Addison, TX 75001. Phone (214) 233-6631. TLX 732561. Booth No 2422.

Circle No 586

EPROM programmer contains buffer for programs as large as 512k bytes

The Promac 16-II is an EPROM production programmer with sockets for 16 devices and a 512k-byte memory buffer. You can partition the buffer into as many as eight data segments, allowing you to program different data sets into multiple EPROMs simultaneously.

The programmer currently handles more than 250 of the most popular 24- and 28-pin devices, including the latest 512k-bit parts. Because the programmer is completely software-controlled, it can easily be upgraded to handle new EEPROM parts.

In addition, an editing feature allows you to change data in the buffer without the need to download the entire data set again from the central computer. Before you start the programming process, which uses a fast algorithm, you can use the programmer's built-in test features to ensure that the EPROMs have been correctly inserted in the sockets,



that all sockets are live, and that the EPROMs are blank. You can verify the correctness of the programming by means of a checksum test.

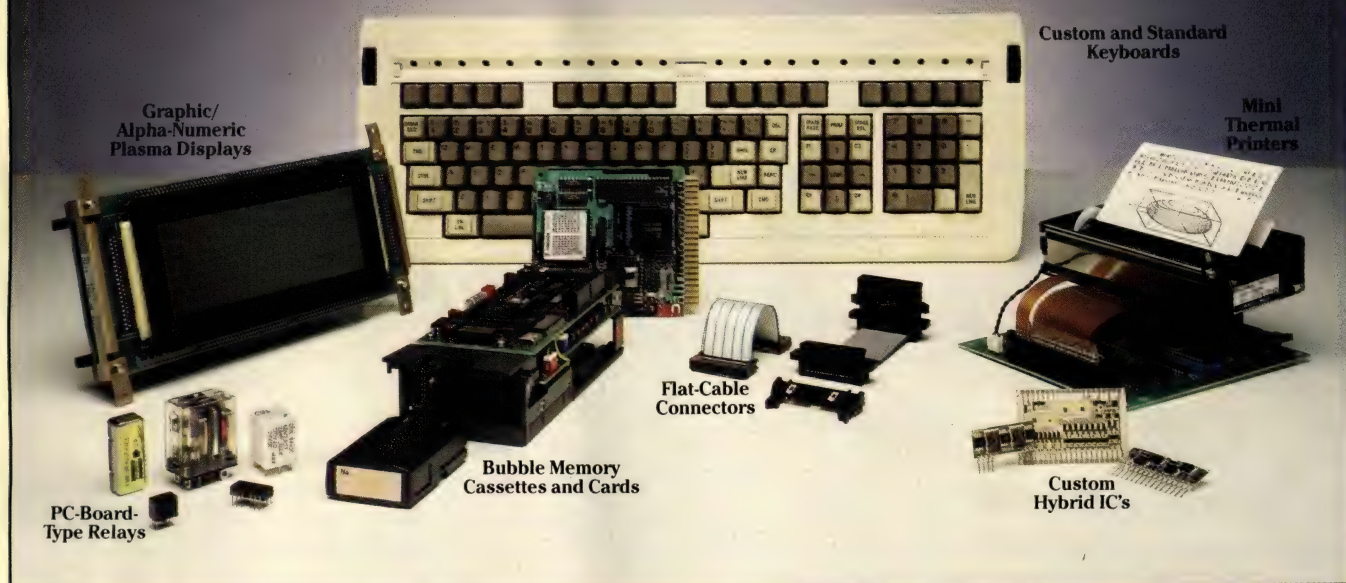
The RS-232C serial interface handles all popular development-system data formats and allows you to control the programmer from a re-

mote IBM PC or PC/XT system. \$3195.

Adams-Macdonald Enterprises Inc, Promac Div, 2999 Monterey/Salinas Hwy, Monterey, CA 93940. Phone (408) 373-3607. TLX 882141. Booth No 2103.

Circle No 583

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PC-Board-Type Relays • Electromechanical, Reed, Mercury-Wetted • UL Recognized, CSA Certified • Printed Circuit Board Mounting • FBR-20 — World's Smallest EMR • Comprehensive Line Application: Process Control, Telecommunications, Automotive and Automatic Test Equipment

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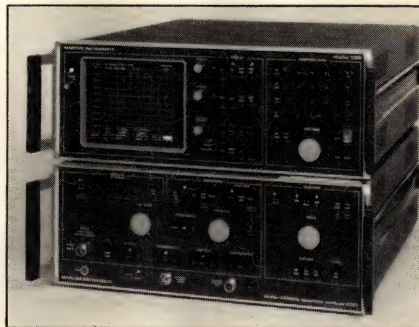
Fujitsu Component of America, Inc.
3320 Scott Blvd., Santa Clara, CA 95054-3197
(408) 727-1700 Telex: 910-338-0190

CIRCLE NO 82

400-MHz spectrum analyzer and display cover audio to VHF frequency range

The 2382 spectrum analyzer and the 2380 display together form a high-accuracy spectrum analyzer with a frequency range spanning 100 Hz to 400 MHz. The frequency response is level within ± 0.4 dB, and total level accuracy is ± 1 dB. Resolution specs 0.025 dB and 1 Hz; a resolution bandwidth as low as 3 Hz allows close-in signal analysis. An automatic self-calibration feature maintains measurement accuracy over long time periods.

The instrument provides two steerable markers for absolute and relative measurements of levels and frequencies; two independent traces



allow detailed signal analysis. An integral tracking generator gives precise response characterization, and the display includes alphanumeric annotations relating to major parameters.

You set up major parameters via keypad switches and dedicated rotary controls; the instrument's special-function keys can save time in setting up complex functions. Both the analyzer and the display are fully programmable via the instrument's IEEE-488 interface, to facilitate incorporation of the instrument into automated test equipment or to allow computer-aided operations. \$19,945.

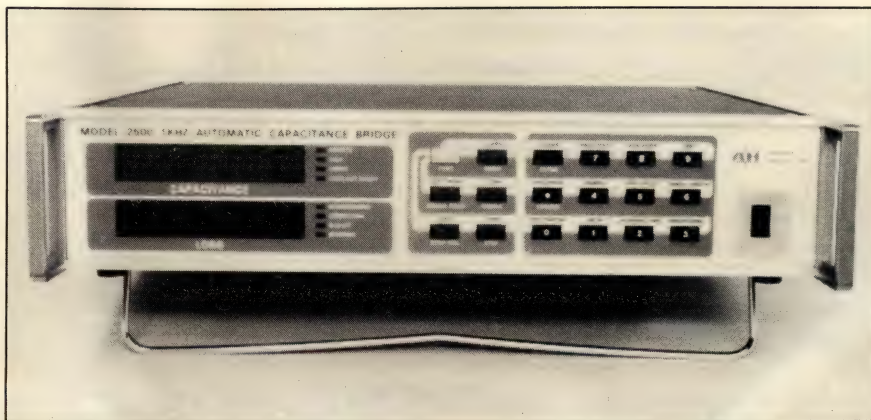
Marconi Instruments, 3 Pearl Ct, Allendale, NJ 07401. Phone (201) 934-9050. TWX 710-991-9050. Booth No 548.

Circle No 582

8-digit capacitance/loss bridge offers resolution of 0.5 aF

Model 2500 is a 1-kHz automatic capacitance/loss bridge that boasts a full ratio-transformer bridge and a temperature-controlled, fused-silica capacitance standard. These allow an accuracy maintained to 10 ppm (0.001%) over a period of one year, temperature stability of 0.02 ppm/°C, and a true resolution of 0.1 pF (0.0000005 pF).

Measurements are made at 1 kHz; you can take full-precision measurements in 0.6 sec and repeated measurements on a stable sample in 50 msec. A tracking feature allows the values of less stable samples to be followed rapidly. Results appear on the 8-digit, variable-brightness LED display. Capacitance is displayed in picofarads; for loss, you have a choice of nanosiemens, dissipation factor, magnitude of loss vector (G/ω), or gigohms. Front-panel LEDs indicate which units you have selected.



The instrument is completely programmable either from the front-panel keyboard or from a remote computer via an RS-232C or IEEE-488 interface. The remote computer can also serve as a data logger. To reduce errors further, a commutation feature periodically reverses the test signal to improve rejection of external and power-related signals. You can also enter data on the

cable's length to allow compensation of cable resistance and capacitance. If measurement errors occur, they are reported by English-language error messages. \$8000.

Andeen-Hagerling Inc, 31899 Miles Rd, Chagrin Falls, OH 44022. Phone (216) 349-0370. Booth No 2320.

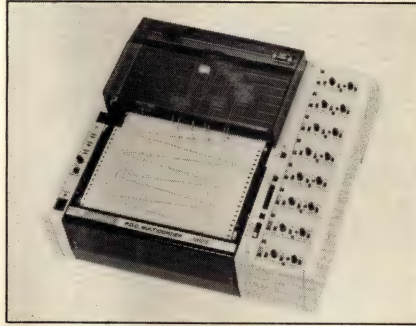
Circle No 585

THE BUS ARCHITECTURE CAREER COMPATIBILITY TEST.

Multichannel strip-chart recorder offers built-in pen-offset compensation

The MLC6625 is a multichannel strip-chart recorder with four, six, or eight pens, set at intervals of 5 mm so that the traces can overlap. A different color can be selected for each pen to make complex traces easier to read, and all pens can record over the full 250-mm paper width with a writing speed of 1200 mm/sec and an acceleration of 3g. Because the offset between pens would ordinarily cause an apparent time displacement between the traces of simultaneous events on different channels, the unit comes with electronic delay circuitry that places all the traces on precisely the same time axis.

A built-in print head automatically prints date, time, and chart



speed. The time can be either elapsed time since turn-on, or the actual time of day. If the recorder is connected to a remote computer via the IF35 interface unit, messages and comments can also be printed. The computer can also start and stop the chart drive, set the chart's speed, issue pen up/down com-

mands, and write time markers.

Optional plug-in units include dc voltage units with autobias (which automatically returns the pen to the zero position whenever it goes off scale), dc current units, and temperature units. Of the temperature plug-ins, thermistor types are linearized to allow direct reading of temperature data. Thermocouple units feature reference-junction compensation as well as linearization.

Prices start at \$4500 for the 4-channel version.

Western Graphtec Inc, 12 Chrysler St, Irvine, CA 92718. Phone (800) 854-8385; in CA, (714) 770-6010. Booth No 2410.

Circle No 587

Half-bridge pulse-width-modulation IC controls fractional-horsepower motors

The GS1E10MA motor-driver IC contains two power-MOS insulated-gate transistors (IGTs), two fast-recovery flyback diodes, and a high-voltage integrated circuit (HVIC). It's optimized for pulse-width-modulation motor-drive applications, and it features a low IGT forward voltage drop (typically 2.5V at 10A) and nonlatching CMOS control logic.

Rated for dc supplies as high as 500V, the package provides isolation between any pin and the heat-sink mounting for voltages as high as 3750V rms, and it meets all requirements for 240V ac systems. The two CMOS control inputs are filtered and decoded to determine the output state. Fixed timing prohibits simultaneous conduction of both IGTs. A sense detector verifies



that the output-voltage state agrees with the control input status after IGT turn-on.

An internal timer generates a fault signal on the Fault line if either IGT enters an overcurrent or out-of-saturation condition, and this sig-

nal causes the module to shut down immediately. \$96.

GE Semiconductor, 318 First St, Liverpool, NY 13088. Phone (315) 457-9333. Booth No 1065.

Circle No 590

DO YOU ENJOY SPENDING NIGHTS AND WEEKENDS ALONE CONFIGURING YOUR SYSTEM?

<i>Career Compatibility Test</i>			
<i>Bus Capability</i>	<i>VME*</i>	<i>MB II</i>	<i>Mark Your Preference</i>
<i>Geographic Addressing</i>		X	
<i>Built-in Self-Test</i>		X	
<i>Software Configurability</i>		X	

Do you enjoy hunting down a misplaced or missing jumper at 2 o'clock Saturday morning?

If so, don't choose the MULTIBUS® II architecture.

Because the MULTIBUS II architecture has an exclusive feature that reduces or eliminates jumpers and dip switches.

It's called geographic

addressing. And it allows boards to be addressed by slot number in software, which eliminates or greatly reduces jumpers. For example, there are no jumpers on the entire line of MULTIBUS II memory boards.

But if you do need jumpers, geographic addressing can still help. Because software can use it to verify correct jumper placement.

And not only is board configuration fully supported in software, but so is identification of board type, manufacturer and the revision level of both hardware and firmware. Geographic addressing also provides a capability for built-in self-test and remote system diagnostics.

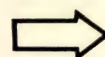
Making things a lot easier for you. And resulting in lower test costs and improved serviceability.

But, by all means, if you enjoy tearing your hair out while re-reading the manual for the umpteenth time, catch the other bus.

It doesn't have geographic addressing, so you could find yourself knee deep in jumper and testing problems. Which means you'll spend many long, gratifying nights working at your bench.

Now, indicate your bus choice in the preference box and turn the page.

*Source: IEEE P1014 Draft 1.2, August 1985.
© 1985 Intel Corp.



DC/dc converters spec 80% efficiency over a 4:1 input-voltage range

The 48T5.15UW is a triple-output dc/dc converter that operates with an input voltage in the 18 to 72V range and provides outputs of 800 mA at 5V and 150 mA at $\pm 15V$ or $\pm 12V$. A feedback-control method embodying pulse-width modulation, combined with coupled-inductor magnetics and a special switching topology, provides load regulation of 2%, line regulation of 0.5%, output noise of 25 mV p-p, and a transient load response of 500 μ sec. Efficiency is 80%.

Other features include a logic-level shutdown-control capability, compatible with TTL or CMOS logic, to conserve battery power during low-voltage operation. The converter is



protected against both thermal shutdown and transient surges.

Models 5D12.075 and 5D15.060 are miniature dc/dc converters for

onboard use in data-acquisition systems. Both these units operate from a 5V supply. The 5D12.075 provides outputs of 75 mA at $\pm 12V$, and the 5D15.060 provides outputs of 60 mA at $\pm 15V$.

Line and load regulation are typically better than 0.1%, and noise is less than 10 mV p-p. Enclosed in a 6-sided copper shield that minimizes conducted and radiated noise, each module measures 1 $\times$ 2 $\times$ 0.375 in. 48T5.15UW, \$130 (single unit); 5D12.075 and 5D15.060, \$26 (1000).

Calex Mfg Co Inc, 3355 Vincent Rd, Pleasant Hill, CA 94523. Phone (415) 932-3911. TLX 338506. Booth No 1247.

Circle No 589

Logic-analyzer family operates at frequencies as high as 100 MHz

The ML4100 family of logic analyzers troubleshoots peripherals as well as 8- and 16-bit μ Cs with clock speeds as high as 100 MHz. The analyzer is connected to the machine under test by means of a 32-bit logic pod, through which you can read data from, or apply control signals to, the target machine.

The analyzer is completely software-driven, and screen menus lead you through the steps needed to perform the operations you want. Three modes are available: timing, state, and disassembly. You can switch between these modes at any time without changing your position in the data buffer relative to the triggering event. An automatic default mode, activated at turn-on, allows an inexperienced operator to start data collection by pressing one button. Starting a more complex



operation, or the automatic test-sequence mode, may require that you press many buttons; however, you can save these commands in a protected file for later execution. Furthermore, one command file can load and start execution of another command file; you can load as many as eight such files into the analyzer and start the execution by pressing a single button. This feature makes it possible for relatively inexperienced technicians to perform quite complex production tests involving

data collection, comparison of the collected data with predetermined test patterns, and initiation of diagnostic routines.

Program uploading to and downloading from a remote computer via an RS-232C serial data link makes a wide range of diagnostic programs available and allows you to transfer data collected from the machine under test to the computer for further analysis.

The ML4100C8 is recommended for use with 8-bit μ Ps; the ML4100C16 supports most 16-bit μ Ps and provides for the extension of the pod from 32 to 62 channels. \$2675 for the ML4100B with 32-channel pod and set of probes.

Ariun Corp, 1931 Wright Circle, Anaheim, CA 92806. Phone (714) 978-9531. Booth No 2223.

Circle No 588

DO YOU LIKE THE CHALLENGE OF RELIABILITY PROBLEMS?

<i>Career Compatibility Test</i>			
<i>Bus Capability</i>	<i>VME*</i>	<i>MB II</i>	<i>Mark Your Preference</i>
<i>Power and Ground Pins (PI Connector)</i>	14	30	
<i>Synchronous Protocol</i>		X	
<i>Bus Parity</i>		X	

Somebody switches on a compressor and your computer system dies.

Swell. Is that the kind of career challenge you got into the systems design business for?

If so, don't choose the MULTIBUS® II architecture. Because MULTIBUS II systems ensure reliability in three ways.

First, a large number of power and ground pins provides superior signal quality.

Then synchronous protocol gives you increased noise immunity. And protects you from metastability problems.

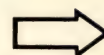
Finally, bus parity protects against disturbances on any line. Whether it's address, data or control.

On the other hand, if dealing with reliability problems gets your blood pumping, the other bus should give you plenty of satisfying excitement.

It has only 14 power and ground pins compared to 30 on the MULTIBUS II boards. And it doesn't offer you the protection of synchronous operation or bus parity. Which means metastability becomes something to watch out for. The other bus can be very challenging indeed.

Indicate your preference and continue.

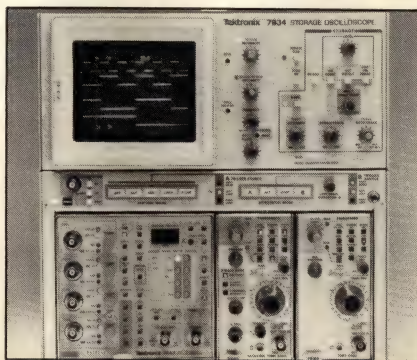
*Source: IEEE P1014 Draft 1.2, August 1985.
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Storage scope features 500-MHz bandwidth, writes at 4 cm/nsec for short transients

The 7934 storage oscilloscope is suited to applications requiring the capture of high-speed transients with rise times as short as 700 psec, low-repetition laser pulses, and random glitches in TTL, ECL, and CMOS logic. The unit comes with a 7B92A dual time-base plug-in module for 500-MHz triggering and a 7A29 vertical-amplifier plug-in module with a 500-MHz bandwidth. The stored writing rate is 4 cm/nsec, allowing single-shot events with rise times as short as 700 psec to be stored on the screen for direct viewing. The company claims that a digital oscilloscope would have to sample at a real-time rate of 1 GHz in order to capture similar transients or random events.

A bistable storage feature provides long viewing times for time-lapse displays of changing events, in



order to check pulse jitter or digital-timing margins. You can also use fast, variable persistence with a reduced scan to examine arcing or plasma discharges. You can also use the storage-level feature, which adjusts the writing rate to suppress random noise on low-level input signals.

The save mode extends viewing time by a factor of 30. The instru-

ment's 10 modes also include multitrace delay, auto-erase, and a nonstore mode that switches the oscilloscope to a conventional 500-MHz unit with a 700-psec rise time.

Four plug-in compartments allow you to choose from more than 30 vertical-amplifier, time-base, digital, and special-purpose modules. Among these are a spectrum-analyzer plug-in module that allows frequency-domain studies in which evolving spectral changes are stored on screen. The 7A42 logic-triggered vertical amplifier and other digital delay modules can tailor the oscilloscope for digital-system analysis. \$20,355.

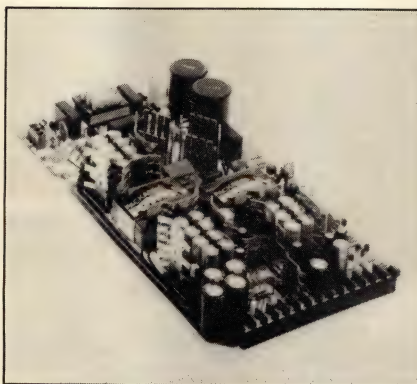
Tektronix Inc, Box 1700, Beaverton, OR 97077. Phone (800) 547-1512; in OR, (800) 452-1877. Booth No 2504.

Circle No 591

Switching power supplies deliver 350W at five different voltage levels

The Maxi-Switcher Series 350W, open-board power supplies provide five different outputs for computers and other electronic systems: 30A at 5V, 10A at 12V, 5A at 24V, 1A at -12V, and 0.1A at -5V. The 5 and 12V outputs have 1% load regulation; the 24V output has $\pm 5\%$ load regulation and high peak-current capability for large-capacity hard-disk drives. The -5 and -12V outputs are regulated to $\pm 0.5\%$.

Overload protection is provided on all outputs, and crowbar over-voltage protection, on the 5 and 12V outputs. You can select input voltages of 90 to 135V ac or 180 to 270V ac by means of a jumper on all models. Soft-start circuitry limits



inrush current and causes all output voltages to rise smoothly to their rated values with no overshoot at turn-on.

Efficiency is 75%, and the hold-up time is 32 msec (two full cycles of

60-Hz power). Physical dimensions are $7 \times 13 \times 2\frac{1}{4}$ in.

Two versions are available: One is UL recognized and certified to CSA standards; the other is TUV-listed for VDE-0806 and IEC-380 standards. Both models meet FCC A and B radiation limits without a shield or cover. An input line filter suppresses line-conducted EMI so that the units meet the conducted-EMI limits of FCC level B and VDE level A. \$525. Delivery, four to 12 weeks ARO.

Computer Products Inc, Compower Div, 2220 Lundy Ave, San Jose, CA 95131. Phone (408) 942-1600. Booth No 2853.

Circle No 595

DO YOU CHERISH MULTIPROCESSING LIMITATIONS?

<i>Career Compatibility Test</i>			
<i>Bus Capability</i>	<i>VME*</i>	<i>MB II</i>	<i>Mark Your Preference</i>
<i>Virtual Interrupts</i>		X	
<i>Number of Interrupt Levels</i>	7	255	
<i>Distributed Arbitration</i>		X	
<i>Number of Arbitration Levels</i>	4	20	

Does the anguish of running out of interrupts give you a masochistic sense of pleasure?

If so, stay away from the MULTIBUS® II architecture.

Because of its virtual interrupt feature, MULTIBUS II boards give you all the sources and destinations of interrupt you need for multiprocessing. Up to 255.

And to make it an even stronger candidate for

multiprocessing, the MULTIBUS II architecture features distributed arbitration. Which assures that no single board can hog the bus. In fact, MULTIBUS II systems are so flexible they can easily accommodate up to 20 bus masters.

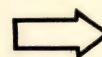
Of course, if you believe that needless frustration builds character, you should choose the other bus.

You'll be stuck with a dedicated interrupt arrangement that effectively allows you only seven interrupts. And because it uses central arbitration, you're effectively limited to only four masters.

Of course, if you want to design systems that are more powerful, useful and flexible, you should choose the MULTIBUS II architecture.

Now turn to the last page and complete the test.

*Source: IEEE P1014 Draft 1.2, August 1985.
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Uninterruptible power supplies boast 2- to 4-msec switching times

The Memorygard series of standby uninterruptible power supplies includes 200-VA, 500-VA, and 2-kVA models for 115 or 230V, 50 or 60 Hz operation. The 200-VA and 500-VA models switch from standby to active mode in 2 msec; the 2-kVA model switches in 4 msec.

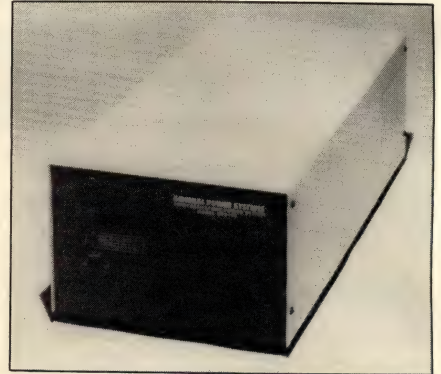
The company also offers on-line UPSs with ratings from 500 VA to 50 kVA. All on-line models are based on true sine-wave technology

and incorporate a make-before-break, solid-state bypass switch.

Prices for standby models begin at \$595 for the 200-VA model and \$1995 for the 2-kVA model. Prices for the on-line models start at \$1650 for the 500-VA unit.

General Power Systems, 1400 N Baxter St, Anaheim, CA 92806. Phone (714) 956-9321. Booth No 349.

Circle No 592



Instrumentation computer offers plug-in modules for a wide variety of test purposes

The Atlas is an instrumentation computer, based on the MP/M II operating system, that accepts two plug-in instrumentation modules such as logic analyzers, in-circuit emulators for 8- and 16-bit μ P chips, μ P trace units, and stimulus/response units for testing circuits and VLSI chips. More than 30 such modules are available. The MP/M device drivers handle the overall operation of the plug-in modules, and special utilities allow the simultaneous operation of more than one plug-in module. If more than two such modules are needed for your application, you can accommodate the extra modules in a 2-slot expansion chassis. The separate ASCII keyboard includes a set of function keys whose specific functions are determined by the plug-in modules in use and are displayed on the screen.

The computer mainframe can operate as a general-purpose computer and can run editors, assemblers, compilers, and other software that's supplied with or is compatible with the MP/M II operating system. You



can thus write your own control programs for the plug-in modules in Basic, Pascal, C, or Z80 assembly language. If you wish, you can set up your control program so that an event occurring in one plug-in module can force an action (such as data sampling and recording) to take place in another plug-in. Standard resources allow the display of state lists, timing diagrams, μ P program disassembly data, and data acquired from the instrumentation.

Standard equipment includes two built-in floppy-disk drives, serial

RS-232C interface and IEEE-488 instrumentation interface, and the MP/M II operating system. A smaller system, the Colt, has a built-in keyboard and space for only one plug-in, but is otherwise similar to the Atlas. Prices are \$9500 for the Colt system and \$13,800 for the Atlas system. Plug-in modules start at \$3200.

Dolch Logic Instruments Inc, 2029 O'Toole Ave, San Jose, CA 95131. Phone (800) 538-7506; in CA, (800) 223-2077. Booth No 446.

Circle No 593

DO YOU THINK GUARANTEED COMPATIBILITY IS FOR SISSIES?

<i>Career Compatibility Test</i>			
<i>Bus Capability</i>	<i>VME*</i>	<i>MB II</i>	<i>Mark Your Preference</i>
<i>Synchronous Protocol</i>		<i>X</i>	
<i>Spec Options</i>	<i>Many</i>	<i>Few</i>	

When a board from manufacturer X doesn't work with a board from manufacturer Y, do you secretly get a perverse sense of delight?

If so, you won't be happy with the MULTIBUS® II architecture.

Since it has a synchronous protocol. Which not only provides noise immunity, but compatibility as well.

In fact, synchronous protocol, because of the very rigorous definition it requires in specs, virtually guarantees compatibility among MULTIBUS II boards from different vendors. And across many generations of VLSI. Assuring a long life for your products.

The other bus has a very unconstrained asynchronous protocol. With lots of spec options. Which gives board manufacturers lots of "leeway." So all sorts of delightfully unpredictable things can happen. For instance, bus timing can change when boards are added or removed from the backplane. Signal edge rates can change too. And options can lead to incompatibilities.

Of course, maybe you think putting up with that kind of frustration is what you trade for higher performance.

Not so. The MULTIBUS II architecture can run faster than the other bus.

So mark your preference now. We'll wait. Then put your pencil down because this is the end of the test.

If you chose the MULTIBUS II architecture more often, read on. If you chose the other bus more often, you might consider a new career direction (or a good course in stress management).

Still with us? Good. Want to learn more? Then call or write for our MULTIBUS II Technical Series: Intel Corporation, Lit. Dept. W262, 3065 Bowers Ave., Santa Clara, CA 95051.

Or call toll-free now at (800) 538-1876.

It's the best career move you can make.

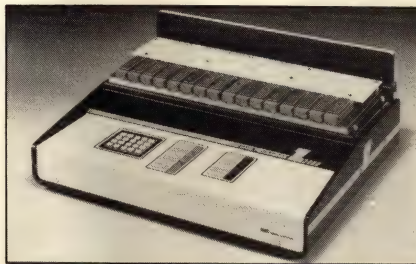


*Source: IEEE P1014 Draft 1.2, August 1985.
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Gang programmer programs 32 EPROMs simultaneously with 95% duty cycle

The Z-3000 gang programmer features quick-change programming boards containing 32-24- or 28-pin EPROM sockets, a 64k-byte data memory (expandable to 256k bytes), 32 LED error indicators, repeat-cycle operation, and a verification algorithm. In a production environment, you can unload and reload all sockets of one board during the time required to program another board; when programming is complete, you merely exchange boards (which requires only three to five seconds). Consequently, once the first board of the run has been prepared, the programmer is in almost continuous use until the end of the run.

Current-sink resistors on all socket lines provide protection against electrostatic damage. Similarly, all data, address, and control lines are clamped to 5.5V to protect both



your EPROMs and the Z-3000 against high-voltage surges. A separate error LED for each socket identifies devices that have failed during a programming or verification operation; for easy identification of the failed devices, the LEDs remain lit when the programming card is removed but turn off at the start of a new programming cycle.

Device-type selection is semiautomatic; a firmware module in each programming card contains the programming algorithms and sevice-

select routines for each device type that the card can program. To select a device type, you just press the Type Select key and then enter the type number via the keypad. You can examine, modify, print, or search the data memory by means of the editing commands. The unit will program EPROMs with storage capacities from 2k×8 bits to 128k×8 bits in the 27XX Series, EPROMs contained in Intel μ Cs of the 874X Series and 875X Series, and EPROMs in the Motorola 68701 μ Cs. Z-3000 master programming unit, \$3500; programming boards, from \$1095. Delivery, four to six weeks ARO.

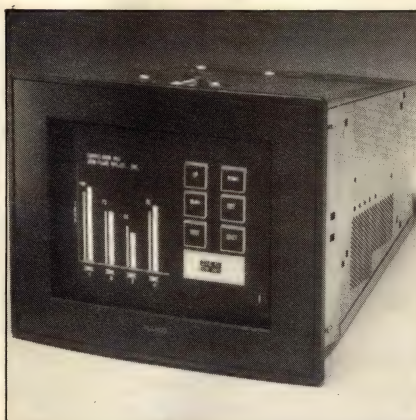
Sunrise Electronics Inc, 524 S Vermont Ave, Glendora, CA 91740. Phone (818) 914-1926. TWX 910-584-3847. Booth No 2428.

Circle No 594

NEMA-certified touch-screen subsystem serves in harsh industrial environments

Series 1020 touch-control screens provide a simple human-computer interface suitable for use in process-control and simple data-entry applications in a manufacturing environment, by operators who are unfamiliar with computers and who may not be able to type. Each unit in the series is a complete interface subsystem consisting of a μ P-controlled CRT display, a touch-sensitive front panel, a logic board and firmware, a power supply, and mounting hardware.

The display is sealed against moisture, dirt, and other forms of contamination, and it operates over the 0 to 60°C temperature range. The panel-mounting version, avail-



able immediately, meets the NEMA-12 environmental requirements; a free-standing unit with tilt-and-swivel base will be available shortly.

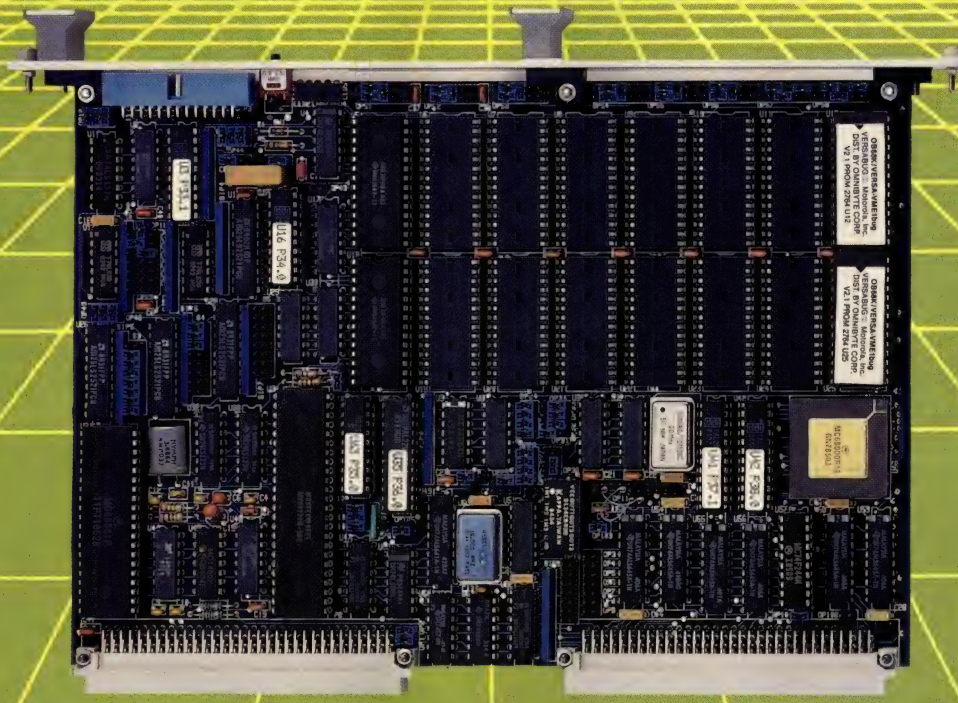
The 1020 touch-screen subsystem communicates with the host computer via an RS-232C serial link. A keyboard connector allows connection of a local ASCII keyboard to convert the unit into a conventional terminal suitable for hostile environments. However, the vendor expects that the touch-screen mode of operation will be the normal mode and that users will program the display to show menus and icons. Less than \$1500. Delivery, six to eight weeks ARO.

John Fluke Mfg Co Inc, Box C9090, Everett, WA 98206. Phone (206) 347-6100. TLX 185102. Booth No 2402.

Circle No 596

OMNIBYTE™

**A fast 12.5 MHz 68000 VME SBC with
16 RAM/ROM sockets. Designed for your
sophisticated control applications.**



OB68K/VME1™

The OB68K/VME1 is an extremely powerful, complete stand alone microcomputer board that is functionally interfaced to the double height (6U) VME bus and is fully compatible with the VME bus standard (Rev. B) by way of the P1 connector.

FEATURES:

- Powerful 12.5 MHz 68000R12 16/32 Bit CPU
- 8 pairs of 28 pin sockets for ROM/RAM
 - ROM 2732, 2764, 27128 or 27256 (at least one pair required).
 - RAM 2K x 8 or 8K x 8 static
- Offboard I/O space 64K bytes (short Address Modifier code)
- (7) Prioritized-BUS or AUTO VECTORED Prioritized Interrupts (One Non-Maskable)
- (2) RS-232C Serial Ports utilizing one 68681 DUART
- (2) 8-bit Parallel I/O Ports with two control lines utilizing one 68230 PI/T
- (1) 16-bit Timer/Counter (in 68681)
- (1) 24-bit Timer/Counter (in 68230)
- System controller functions are supported. They consist of:
 - (1) 4-level Prioritized bus arbiter
 - (1) 16-MHz system clock
 - (1) Power-on Reset Generator
 - (1) Manual Reset Generator

(1) System watch dog timer

- All System controller functions may be inhibited for Multi-Master System use if desired.

Our extensive quality control procedures give you a highly reliable product backed by Omnibyte's two year limited warranty. Software available for the OB68K/VME1 includes the optional VME1 BUG™ monitor/debugger and a variety of other packages. Find out more about our OB68K/VME1. Write or call our Sales Department for our free data sheet or send \$10.00 for a detailed technical manual. Contact our Marketing Manager, Peter Czuchra.

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**A Look at Today. . .
A Vision of Tomorrow.**



OMNIBYTE CORPORATION
245 W. Roosevelt Rd.
West Chicago, IL 60185-3790
(312) 231-6880
Intl. Telex: 210070 MAGEX UR

Autoranging digital oscilloscope contains built-in graphics printer

The SE 571 is an autoranging digital oscilloscope equipped with two 25-MHz A/D converters and its own graphics printer. The unit can display two signals, each at frequencies as high as 10 MHz, by means of nonlinear SI interpolation. The unit displays an additional eight digital input channels as amplitude/time plots or as alphanumeric data.

Cursor controls allow you to perform amplitude and time-base analysis; other circuitry allows you to perform averaging, addition, and multiplication of input signals be-



fore displaying them. The built-in thermal printer prints all information displayed on the screen, together with measurement parameters, in as little as 10 seconds. \$6500.

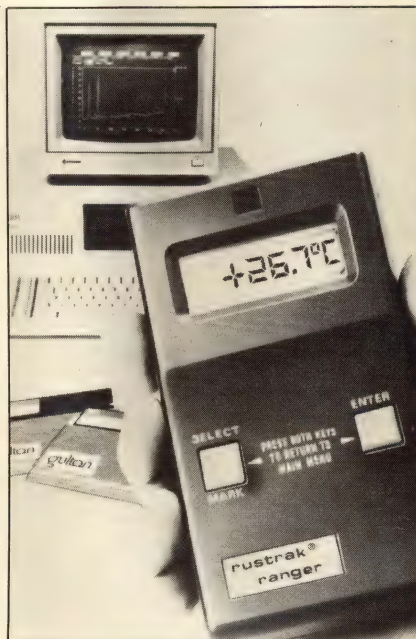
BBC-Metrawatt/Goerz, 2150 W 6th Ave, Broomfield, CO 80020. Phone (800) 821-6327; in CO, (303) 469-5231. Booth No 2110.

Circle No 599

Data logger stores as much as 100 days of trend data from four analog channels

The Rustrak Ranger is a compact, 4-channel data logger that can store as much as 100 days worth of trend data in its internal memory. Data pods that provide signal conditioning allow the logger to accept analog input signals from most standard types of sensor. The unit samples data continuously and stores it in compressed format; data that does not change is not stored, but timing information is stored to indicate the start and end of a long run of unchanging data. At the end of the run, the stored data can be transferred to an IBM PC or compatible computer over an RS-232C link.

The Pronto applications software supplied with the data logger transfers data from the logger to the host computer and expands the compressed format to numbers with 14-bit precision. The software provides two modes: the quick-plot mode, which plots the raw data directly on the screen or printer, and for which no technical expertise is



required; and the analyze mode.

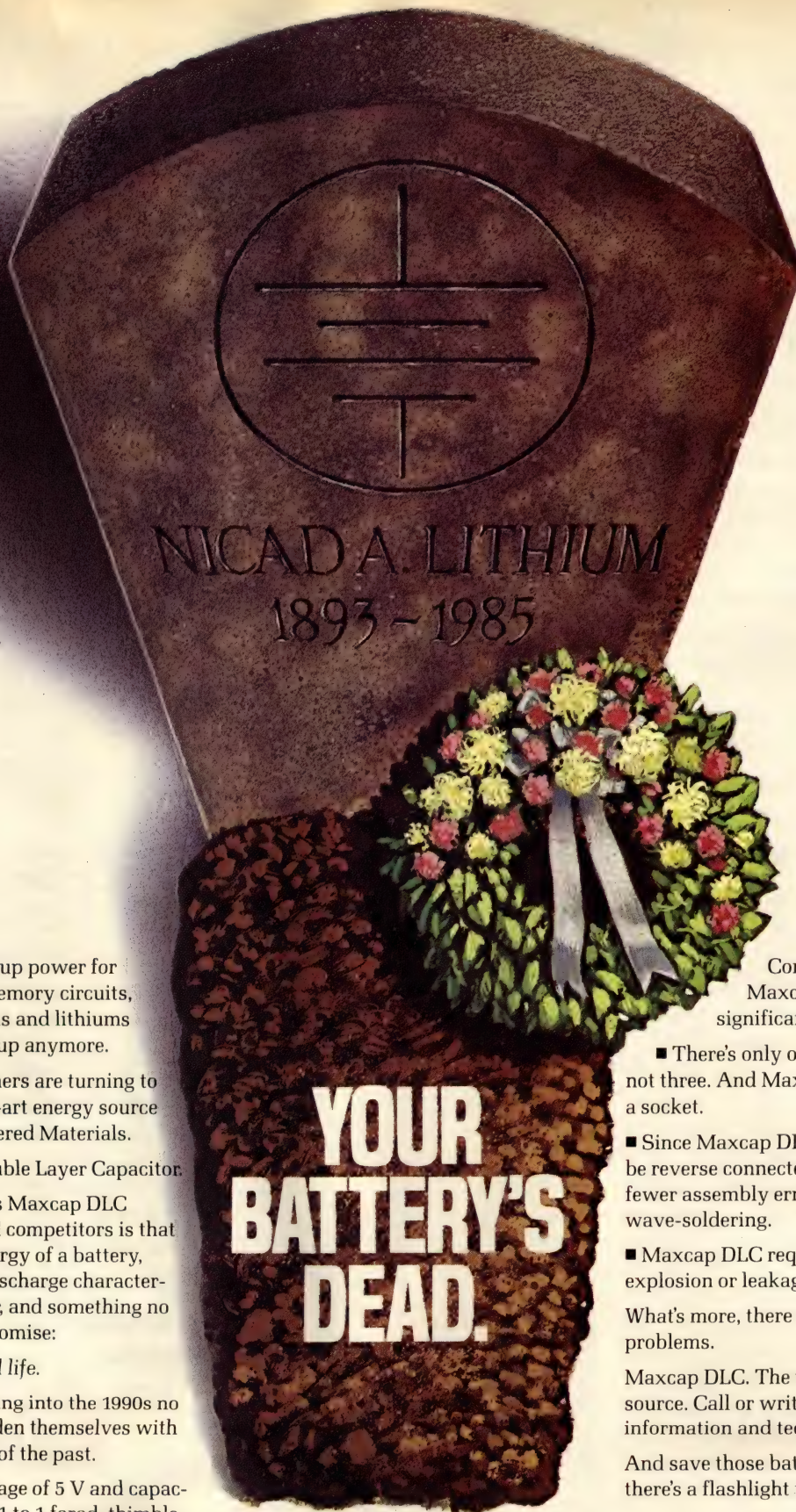
In the analyze mode you can plot data from nine different files for comparison; you can group the plots by sensor type on the screen, or overlay plots from several different

files. A zoom feature allows you to isolate a window containing as little as one minute of data and expand it for detailed examination on the screen. You can also annotate the plot with textual notes before re-writing the disk file. An export feature allows you to store the data as ASCII characters in a format suitable for export to a spreadsheet or other analytical program.

The software requires the Hercules monochrome graphics card with a monochrome monitor. A color version for use with the Hercules color graphics card or the IBM Enhanced Graphics Adapter will be available shortly. Rustrak Ranger and Pronto software, \$449; data pods, from \$52.

Gulton Industries Inc, Graphic Instruments Div, East Greenwich, RI 02818. Phone (800) 343-7929; in RI, (401) 884-6800. TWX 710-387-1500. Booth No 357.

Circle No 598



NICAD A. LITHIUM
1893 - 1985

YOUR BATTERY'S DEAD.



As backup power for CMOS memory circuits, the ni-cads and lithiums just don't measure up anymore.

Now, circuit designers are turning to a new, state-of-the-art energy source from Sohio Engineered Materials.

The Maxcap™ Double Layer Capacitor.

What distinguishes Maxcap DLC from its antiquated competitors is that it gives you the energy of a battery, the rapid charge-discharge characteristics of a capacitor, and something no battery can ever promise:

Virtually unlimited life.

So designers working into the 1990s no longer have to burden themselves with power sources out of the past.

At its nominal voltage of 5 V and capacitance values of 0.01 to 1 farad, thimble-size Maxcap DLC can be charged and discharged indefinitely without maintenance or replacement. Since there's no need for access, equipment can be

made smaller and simplified. You can also reduce backup circuit and assembly costs.

Compared to batteries, Maxcap DLC delivers these significant cost savings:

- There's only one extra component, not three. And Maxcap DLC doesn't need a socket.
- Since Maxcap DLC is nonpolar, it can't be reverse connected, so you'll have fewer assembly errors. And you can use wave-soldering.
- Maxcap DLC requires no toxicity, explosion or leakage safeguards.

What's more, there are no disposal problems.

Maxcap DLC. The timeless energy source. Call or write for complete information and technical details.

And save those batteries. Somewhere, there's a flashlight that can use them.

Sohio Engineered Materials Company
Semiconductor Products Division
P.O. Box 664
Niagara Falls, NY 14302
716/278-3954

Maxcap DLC shown actual size above.



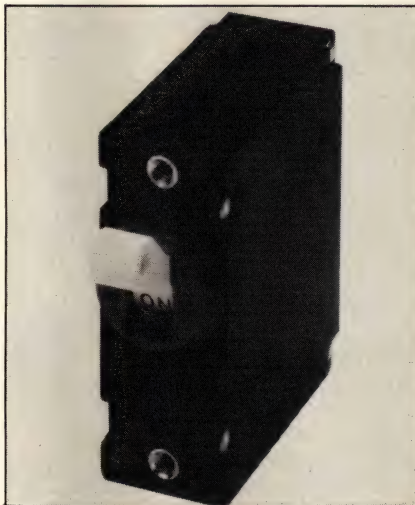
CIRCLE NO 89

**Sohio
Engineered Materials
Company**

Smart circuit-breakers distinguish between inrush and overload conditions

The A and B Habit Breakers are circuit-breakers that distinguish between the high inrush current that is normal when incandescent lamps and some types of capacitive loads are turned on, and true overload conditions. The breaker ignores momentary spikes that reach values as high as 25 times the rated current, yet it reacts quickly to a true overload. These breakers can withstand 10,000 operations and operate reliably over a temperature range from -40 to +85°C.

UL and CSA approvals have been granted on the A and B Series



breakers, which meet IEC and VDE spacing requirements. The breakers are available in single- and multipole configurations, with one actuator per pole or one actuator per unit. Prices start at less than \$250. Delivery, eight weeks ARO.

Carlingswitch, 505 New Park Ave, West Hartford, CT 06110. Phone (203) 233-5551. Booth No 2248.

Circle No 600

Microscope eliminates binocular eyepieces to effect stereoscopic inspection

The TS2 zoom stereo microscope lets you view a projected spatial image in three dimensions. A rotating multiple mirror disk projects two images side by side at the average separation of the operator's eyes. These images are not projected onto a ground-glass screen, which would not be able to provide the required resolution and depth of focus; rather, they are projected directly to the operator's eyes.

The optical system enlarges the bundles of light rays representing the left- and right-hand images to a degree that permits considerable head movement at the viewing position, along both lateral and front/back axes. This projection system not only eliminates the need for the operator to remove prescription spectacles when viewing, but also, according to the vendor, greatly reduces eye strain and fatigue.

The stereo microscope provides four zoom ranges of magnification:

6.3 to 42; 9 to 60; 13.5 to 90; and 18 to 120. Field diameters in these ranges vary from 28.5 mm (at a



magnification of 6.3) to 1.5 mm (at a magnification of 120), at working distances of 113 mm (lowest range) to 18 mm (highest range). A quick-change reticle carrier allows you to insert a variety of reticles in the optical system.

A built-in camera selector allows the stereo image to be diverted from the operator to a camera mounting. Optional accessories include substage, oblique, semicoaxial, full-coaxial, and ring illuminators; camera adapters; 35-mm and Polaroid Land cameras; and other modules that adapt the microscope to almost any application. From \$6000.

Vision Engineering Inc, 570 Danbury Rd, New Milford, CT 06776. Phone (203) 355-3776. Booth Nos 2424 and 2426.

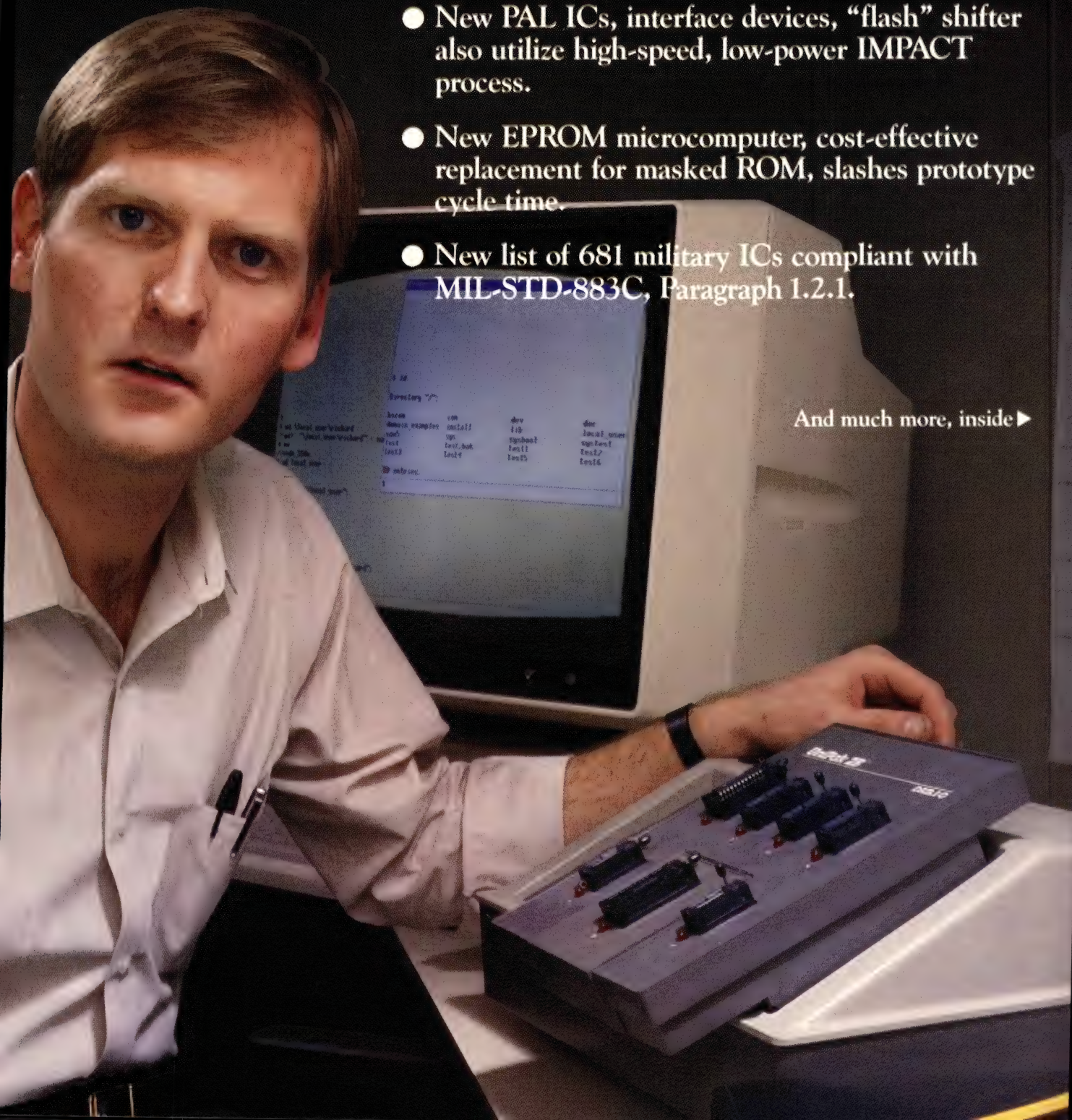
Circle No 597

"WHAT'S NEW FROM TEXAS INSTRUMENTS?"

IMPACT PROMs that boost speed by 29% or cut power by 43%.

- New PAL ICs, interface devices, "flash" shifter also utilize high-speed, low-power IMPACT process.
- New EPROM microcomputer, cost-effective replacement for masked ROM, slashes prototype cycle time.
- New list of 681 military ICs compliant with MIL-STD-883C, Paragraph 1.2.1.

And much more, inside ►



IMPACT PROMs deliver 25-ns speed at industry-standard power.

New Series 3 IMPACT™ PROMs from Texas Instruments make 16K-memory performance upgrades quick and easy. If speed is your most critical parameter in a high-complexity PROM, you can achieve it now without paying a power penalty. Just design in TI's new 25-ns, 175-mA IMPACT PROMs: The TBP38S165-25 ($2K \times 8$) or the TBP34S162-25 ($4K \times 4$).

Or use the world's fastest 16K registered PROMs. TI's TBP34R165-18 ($2K \times 8$), with a minimum address-to-clock setup time (t_{su}) of only 18 ns, is nearly $2\frac{1}{4}$ times faster than the closest competitor. And the TBP34R162-30 ($t_{su} = 30$ ns) is the only $4K \times 4$ registered PROM on the market.

Standard speed at 43% less power

You can also cut power without sacrificing speed, using TI's new TBP38L165-35 IMPACT PROM. It is pin-for-pin compatible with existing $2K \times 8$ PROMs and operates at the same 35-ns speed, but instead of 175 mA, it draws only 100 mA. TI's broad family of Series 3 IMPACT PROMs also includes 256-bit, 1K and 2K devices.

Reliability built in

IMPACT PROMs are designed by TI for exceptional reliability. Current densities, metal spacing, and contact sizes are all conservatively designed. Electrostatic-discharge tolerance up to 4,000 V

is designed in. During programming, TI-developed titanium-tungsten fuse links insulate themselves with titanium-oxide caps. Electromigration is eliminated by copper-doped aluminum in the first-level interconnection. And you can program any of TI's new Series 3 PROMs on widely available commercial equipment, using TI's standard Series 3 programming algorithm.

Shift 32 positions in less than 29 nanoseconds.

Now TI's 2- μ m IMPACT technology also brings you high-speed "flash-shift" operations — with the new 74AS8838 32-bit barrel shifter. Shifting as many as 32 positions in a single 29-ns instruction cycle, it can dramatically increase throughput in such applications as graphics systems, wide-word CPUs, and array processors. At an energy cost of less than 1.5 W, you get higher speed with lower power, in a single 84-pin ceramic pin-grid-array package.

You can program the 74AS8838 for logical, circular, or arithmetic shifts. Its two 3-state, 16-bit outputs give it the versatility to be configured as a 32-bit-in, 32-bit-out barrel shifter, as a 16-bit funnel shifter, or as a 16-bit shifting transceiver. And it can drive buses directly with 24-mA low-level output — with no additional circuitry.

The 74AS8838 barrel shifter, first

device in TI's 74AS88XX 32-bit processor chip set, is available today through your local authorized Texas Instruments distributor.

IMPACT technology doubles speed of new PAL ICs.

Four new exclusive-OR programmable-array logic (PAL®) ICs from TI feature the highest speed available today. Their 20-ns propagation delay at 180 mA makes them twice as fast as any comparable devices.

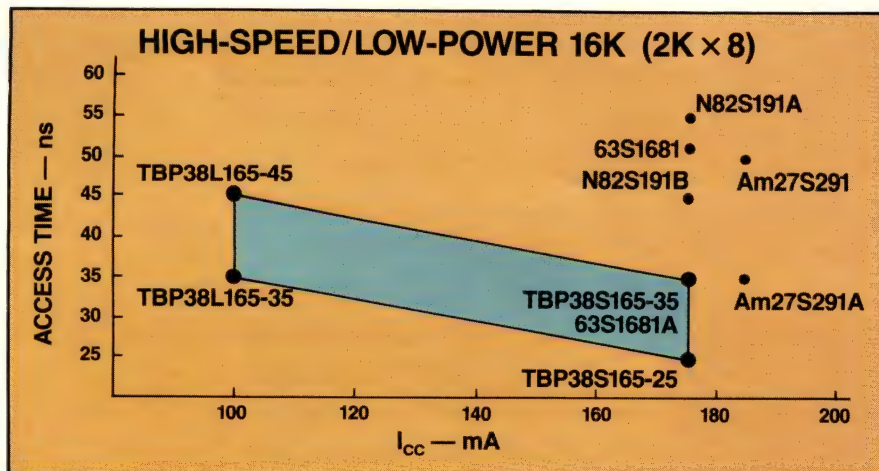
These devices — TIBPAL20L10-20, TIBPAL20X4-20, TIBPAL20X8-20, and TIBPAL20X10-20 — are designed primarily for counter-intensive applications. The exclusive-OR feature suits them ideally to digital voice applications and video-screen information correction. They can also be useful in memory addressing and mapping.

Programmable logic sequencer is 250% faster because of IMPACT processing.

Still another new product in TI's growing line of high-speed programmable logic devices is the TIB82S105B. At 50 MHz, it is $2\frac{1}{2}$ times as fast as functionally equivalent $16 \times 48 \times 4$ field-programmable logic sequencers — at the same 180-mA power. Unlike them, however, it maintains that speed even when using many product terms.

Because of its improved clocking scheme, the IMPACT TIB82S105B is not a direct replacement for the TI or Signetics N82S105A. But it is ideal for those new high-speed state machines designed to control peripheral I/O, dynamic memory systems, and video blanking systems.

For more detailed information about any of TI's growing line of high-speed, low-power IMPACT products, just check the appropriate box on the attached reply card and return it to TI.



Bracketing the speed/power spectrum, TI's IMPACT PROMs cut power requirements from 180 to 100 mA for "standard" 35- to 45-ns access time. Or at 180 mA, they can give you 25-ns speed.

Texas Instruments quality recognized in Tokyo and Detroit

Outstanding Texas Instruments quality-assurance programs were lauded during 1985 both at home and abroad. In June, Ford Motor Company granted TI linear products the coveted Q1 Award. And in November, TI's wholly owned Japanese semiconductor operation received the prestigious Deming Prize. Both awards recognize exceptional levels of quality and reliability, achieved through aggressive defect-prevention programs.



First Ford Q1 Award to a semiconductor supplier

Ford Motor Company's Q1 Award to Texas Instruments Linear is the first ever to a major U.S. semiconductor manufacturer.

Qualification is based on a demonstrated defect-prevention program,

along with Ford's review of warranty returns, specifically keying part numbers to failures. Thus it recognizes both initial product quality and continuing reliability.

Both quality and reliability are attributes that TI Linear has pursued aggressively through its "monitor program," begun in 1979. The goal of the program has been to achieve levels of quality and reliability equal to or better than the best worldwide competition. And the Ford Q1 Award is one visible token of its success.

First U.S. winner of Japan's Deming Prize

At ceremonies on November 11 in Tokyo, the Japanese Union of Scientists and Engineers awarded the prestigious Deming Prize for total quality control to TI's bipolar semiconductor operation in Japan.

The prize, never before won by a wholly U.S.-owned company, recognizes outstanding quality-control achievement in all aspects of business — including marketing, engineering, manufacturing, and support. It is named for W. Edwards Deming, the American statistician whose work in defining and measuring quality control in Japan after World War II became the basis for the legendary Japanese commitment to quality. In 35 years, the Deming Prize has been awarded to only 48 individuals and 111 institutions. Texas Instruments Japan, Ltd. was one of only eight companies so honored in 1985.



As is the case with the Ford Q1 Award, sensitivity to customers' requirements is a key factor in selecting winners of the Deming Prize. TI's successful commitment to quality and reliability in support of all our customers' needs has been demonstrated twice again. And TI is justifiably proud of this achievement.

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SCALDSYSTEM is a registered trademark of Valid Logic Systems Incorporated.

P-CAD is a registered trademark of Personal CAD Systems Inc.

FutureNet is a registered trademark of FutureNet Corporation.

IBM PC is a registered trademark of International Business Machines Corp.

More news upcoming from TI in the next issue:

- A new CMOS version of TI's trend-setting TMS320 Digital Signal Processor.
- More new additions to TI's growing family of IMPACT PAL ICs.
- New CMOS standard cells and gate arrays that augment TI's leadership in Application-specific Integrated Circuits (ASICs).
- And more ...

For more information...

Check the appropriate square on the reply card, or write **Texas Instruments Incorporated, Department SY093, P.O. Box 809066, Dallas, Texas 75380-9066.**

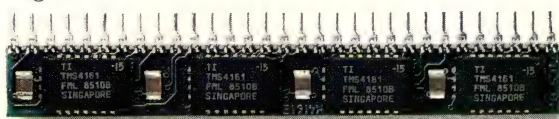
**TEXAS
INSTRUMENTS**

Creating useful products
and services for you.

8 new ways TI can help sharpen

1 new alternative for memory-systems design: TI SIP DRAM modules.

Memory-intensive packaging for the future is available today — in TI's highly reliable modules in single-in-line packages (SIPs). With them you can have the many advantages of surface-mount technology (SMT) — while using through-hole-mounted or socketable packages. Thus without changing your manufacturing technology, you can increase memory density by a factor of up to 3.5 over dual-in-line packages (DIPs). And you can simplify board layout while facilitating replacement and future upgrades. Each SIP module uses DRAM chips and plastic leaded chip carriers (PLCCs),



surface-mounted along with decoupling capacitors on an epoxy substrate. Since all connection points are on one edge of the substrate, the module "stands on end" to make the most of your board area.

TI's full line of SIP memory modules — from 64K × 4 to 256K × 9 and 1M × 1 — includes standard DRAMs and Multiport Video RAMs in various organizations. And all are available through your authorized TI distributor.

For more information, just check the appropriate box on the reply card.

Memory can be 3.5 times denser using fully-qualified, production-proven RAMs configured in SIP modules. TI SIPs combine the density of surface-mount technology with economies of through-hole insertion.

2 Interface performance enhanced by TI.

Also new from Texas Instruments is an improved direct replacement for the CN5812 vacuum fluorescent display driver. TI's TL5812 is 11% faster and

draws 60% less current. With an output voltage swing of 70 V and an output source-current capability of 40 mA.

Only TI's patented BIDEFET technology — combining bipolar, double-diffused MOS (DMOS) and N-channel and P-channel CMOS transistors on the same chip — makes these improvements possible. And at a competitive price.

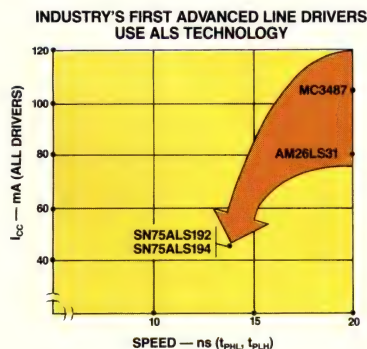
3 Fast line drivers and bus transceivers from TI.

The new SN75ALS192/194 quadruple EIA Standard RS-422-A differential line drivers, TI's exclusive ALS 1.5 process technology (oxide-isolated Advanced Low-power Schottky) yields the best speed/power ratio in the industry: at approximately half the power consumption, these devices are 30% faster than the competition.

A new family of differential bus transceivers, SN75176B, 177B, 178B, and 179B, are faster than earlier versions. Designed for bidirectional communication on multipoint transmission lines in noisy environments, they meet

EIA Standards RS-422-A and RS-485. Typical propagation time is only 22 ns.

Want to know more about these new interface products from TI? Just check the appropriate box on the reply card.



Advanced TI line drivers are 30% faster, typically draw only half the power of the devices they are designed to replace.

4 Fast, economical new 8-bit SAR A/D converters.

Now Texas Instruments offers 8-bit SAR (serial-approximation resolution) A/D converters that are as economical as any you can use. And because they use LinCMOS™ polysilicon-gate-process technology, they are unsurpassed in speed. TI's TLC549 analog-to-digital converter performs 40,000 conversion cycles per second (cps), while the new TLC548 pushes speed to an unprecedented 45,500 cps. At any supply voltage between 3 and 6 V. And typical power consumption is only 6 mW.

Performance of the serial-approximation algorithm is not only fast. It's accurate: Conversions are performed with the guaranteed low error rate of ±0.5 LSB (least significant bit) across the temperature range from -55° to 125°C.

5 681 military TI devices comply with 1.2.1.

Now designers of military electronics have the broadest choice ever of devices that comply with the requirements of MIL-STD-883C, Paragraph 1.2.1. The vast majority of TI's military ICs — 681 different devices — now qualify:

Product Type	Number
ALS/AS	83
TTL	131
LS/S	238
HCMOS	80
PAL ICs	16
Linear	113
Memory/LSI	19
MOS DSP	1
TOTAL:	681

For more detailed information on specific TI military devices, just check the appropriate box on the reply card.

your competitive edge.

6

Keeping you competitive: ASICs and TI.

If you're looking for increased system-level integration and performance, shorter design-cycle time, and reduced VLSI development costs, take a hard look at application-specific integrated circuits (ASICs). And a long look at TI.

Broad choice lets you pick the right implementation

Texas Instruments supports an extensive library of 3- μ m CMOS standard cells — more than 200 of the standard SN54/74 TTL functions you have designed with for years — including MSI, analog, and procedural LSI functions like RAM, ROM, PLA, and ALU. In addition, high-drive cells (up to 48 mA) are true TTL replacements.

From TI's new family of advanced standard cells you'll be able to choose among more than 280 functions and achieve increased system integration and performance.

Or for the performance you need, and quick turnaround to get your product to market fast, there's TI's DLM TAC-H and TAC-VH silicon-gate CMOS gate-array family. These devices, fully alternate-sourced, offer complexities from 440 to 8,000 gates.

Extensive design support

Whatever level of help you need, you get it from TI. In your design cycle as well as in meeting your prototype and production requirements *on time*. TI's proven expertise and worldwide manufacturing facilities are your assurance of dedicated support and products in the volume you require. And you have a wide range of package options: DIPs, SOs, PLCCs, pin-grid arrays — from 8 to 179 pins.

Design your own way

You can reduce your costs and speed your ASIC design with TI because you don't need special proprietary software or design tools. And you can do it at a TI regional design center or at your own work station. Because TI's cell libraries are supported by most work stations, including Daisy LOGICIAN®, MEGALOGICIAN®, and

GATEMASTER®, Mentor IDEA 1000®, Valid SCALDSsystem®, and P-CAD® and FutureNet® in IBM PC® environments.

TI's worldwide network of 13 training and design centers, staffed with experienced ASIC design engineers, can provide access to work stations, as well as mainframe capability. And you can learn ASIC design in one of TI's unique hands-on workshops. Using TI's semicustom libraries with a real-world standard-cell example, you'll learn every phase of design from schematic capture through test-pattern generation and simulation.

Select TI distributors can also give you local access to TI's leading-edge ASIC options, with dedicated facilities, tools, and trained engineers.

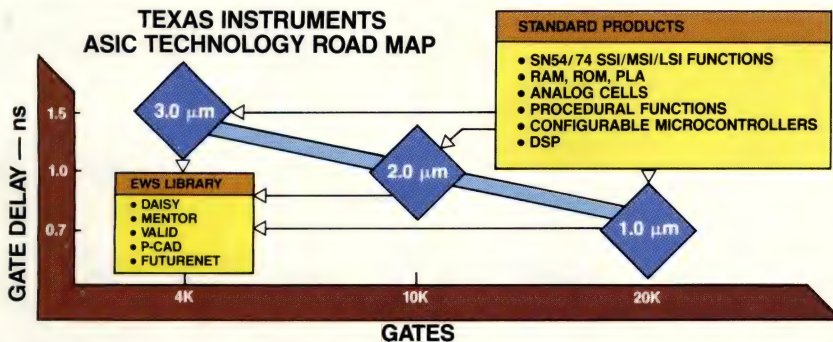
To find out more about what TI ASICs can mean to you, check the appropriate box on the return card.

8

And now, a new, easy-to-use EPROM microcomputer.

TI's new TMS7742 EPROM microcomputer can cut to zero your lead time for development, prototyping, field tests, and product qualification. And it bridges the gap to ROM-based volume production. For low-volume applications, it can be a cost-effective alternative to mask-programmed ROM. Its 4K bytes of on-chip EPROM are identical to TI's TMS2732A — transferred into the chip area vacated by masked ROM. So if you can program the TMS2732A you can program the TMS7742. This new microcomputer provides EPROM capability for the TMS7020, the TMS7040, and the new TMS7042 ROM microcomputer.

Also new to TI's TMS7000 family is the ROM-less TMS7002 microprocessor. Both the TMS7002 and the TMS7042 feature 256 bytes of RAM, a serial port for USART and serial I/O functions, 32 I/O lines, and three timers. And with their 60% performance increase over earlier TMS7000 ICs, they can improve system performance in such applications as disk and tape drives, printers, and industrial and motor controls.



Advancing technology in ASICs need not demand new rules and tools. Your investment in hardware and training is protected when you move up with Texas Instruments to faster, more complex ASIC functions.

7

New series of input-latched and registered PAL ICs lowers parts counts.

Eight new 30 MHz PAL devices from TI are the first input-latched (TIBPAL19XX) and input-registered

(TIBPALR19XX) PAL ICs in the marketplace. Functionally similar to TI's TIBPAL20XX series, they include either 11 D-type transparent latches or 11 D-type input registers on chip. This added circuitry allows you to synchronize inputs without external registers or latches. These devices can reduce your parts counts and simplify your design task in a wide range of applications such as random logic, bus-interface logic, and input synchronization to custom controllers.

High-density IMPACT circuits speed logic, memory access.

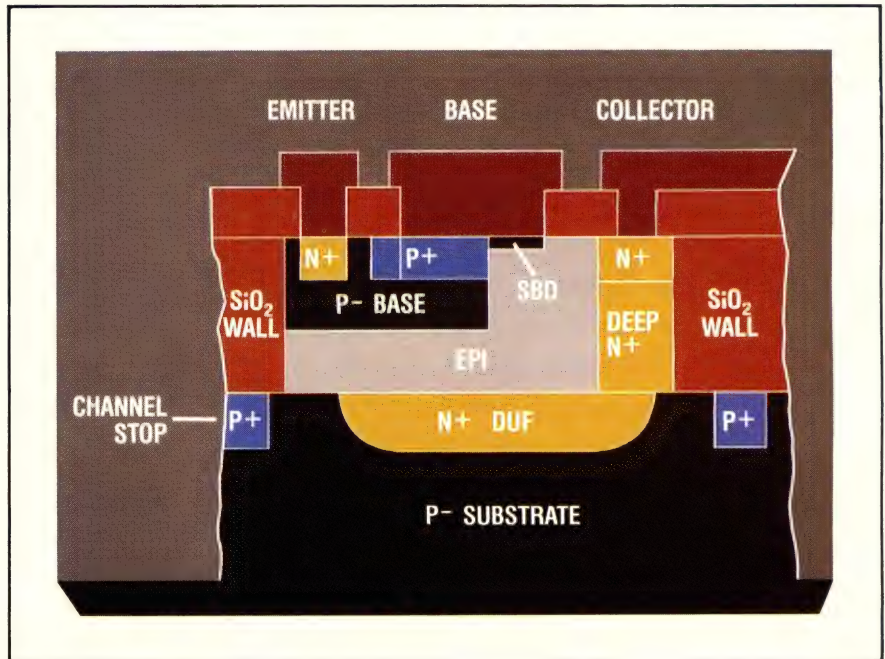
TI's unique *Implanted Advanced Composed Technology (IMPACT)* capitalizes on the advantages of ion implantation, oxide isolation, and composed-masking techniques to increase the speed and density of bipolar ICs.

This innovative technology dramatically reduces the size and the sidewall capacitance of circuit elements (*see diagram*). As a result, speed/power ratios are significantly improved: In PROMs that cut power consumption by 43%, or more than double the speed (*see story opposite*). In PAL ICs that reduce propagation delay by as much as 40% — to only 15 ns at 180 mA.

With the high speed and low power that TI's IMPACT process makes feasible, its potential for large-scale integration will reduce package counts in many high-complexity circuits.

Composed masking yields high density

In composed masking, critical components are defined on the chip with a minimum number of masks. Thus they can be more tightly defined and more densely spaced than by conventional masking.



A major reduction in capacitance results from the 2- μ m feature size which TI's IMPACT processing makes possible. Silicon dioxide is the isolation material. Switching speed is further enhanced by utilizing this silicon dioxide for emitter and base sidewalls.

The IMPACT process also makes it possible to insulate critical base and emitter components with oxide walls. This insulation reduces sidewall capacitance, which, at the 2- μ m dimensions of IMPACT features, can represent as much as half the overall capacitance. Small size and oxide walling together contribute significantly to

the increase in switching speed.

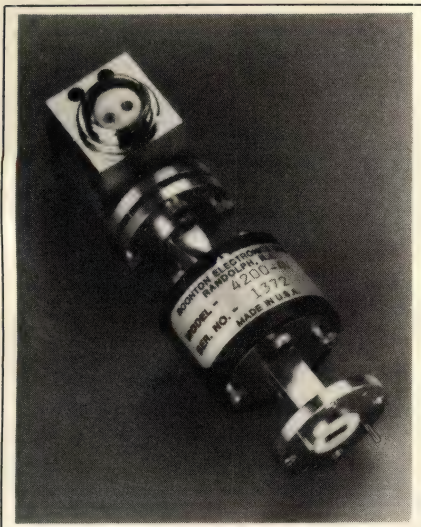
DRAM technology spurs IMPACT growth

The IMPACT process is not a direct descendant of DRAM technology. Nevertheless, TI's commitment to DRAM production has provided IMPACT technology with vital processes.

It was the DRAM effort, for example, that drove photolithography to its present advanced state and contributed key dry-etching processes. Ion implanters designed to produce CMOS DRAM ICs enhance the quality — and the economy — of TI's bipolar IMPACT ICs. And this vital "cross-fertilization" from VLSI memory is one reason Texas Instruments — almost alone among U.S. semiconductor manufacturers — is committed to the development and manufacture of DRAM devices.

◀ More chips per slice help cut costs. The 150-mm wafers now used on TI's advanced MOS 256K DRAM wafer-fabrication line have 125% more area than the 100-mm slices formerly used.



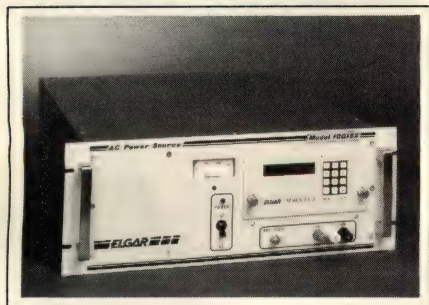


POWER SENSORS

U-band (40 to 60 GHz) and W-band (75 to 110 GHz) sensors for the company's Model 4200 dual-channel power meter extend the meter's coverage above its previously 18- to 75-GHz range. SWR is less than 1.3 for these millimeter-wave sensors. Basic measurement accuracy is $\pm 0.5\%$ ($\pm 0.25\%$ for the K band). The dual-channel setup permits gain or loss measurements with only one power meter. Model 4200-4U (U-band) \$4630; Model 4200-4W (W-band) \$5670; Model 4200 meter, \$2750. Delivery, stock to six weeks ARO.

Boonton Electronics Corp., 791 Route 10, Randolph, NJ 07869. Phone (201) 584-1077. TWX 710-986-8215. Booth No 1748.

Circle No 601



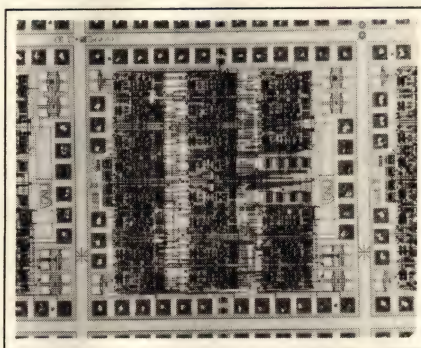
AC POWER SUPPLIES

Model 1001SX and Model 1751SX solid-state frequency converters suit power-supply testing and are compatible with most ATE systems.

The units provide 400% peak power and can supply rectifier-type loads without affecting their output regulation or encountering sine-wave distortion. Continuous-current ratings are 40 and 70A for Model 1001SX and Model 1751SX, respectively. The supplies come in 19-in. rack-mount enclosures. Plug-in oscillators allow the simulation of dropouts. The supplies are available in 1-, 2-, or 3-phase configurations with voltage ranges of 0 to 65, 130, or 260V. Output frequency ranges from 45 to 1000 Hz, and THD is less than 1%. The supplies also feature overload, short-circuit, and over-temperature protection. From \$4810.

Elgar Corp., 9250 Brown Deer Rd, San Diego, CA 92121. Phone (619) 450-0085. TLX 211063. Booth No 543.

Circle No 602



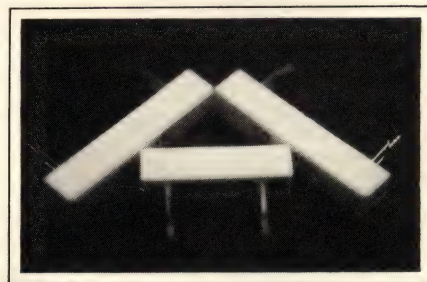
CUSTOM CHIPS

This family of analog arrays includes the Quickchip 2, 2S, and 3. The Quickchip ICs are arrays of transistors, resistors, and capacitors. The Quickchip 2 is fabricated in a bipolar process to produce a 15V, 6.5-GHz chip; the Quickchip 3 uses a 65V, 2.5-GHz process. Quickchip 2 has 214 npn and 110 pnp transistors organized into 10 cells along with 946 resistors and 40 programmable capacitors (the 2S is a smaller version of the 2). The Quickchip 3 has 198 npn and 36 pnp transistors organized into six low-voltage cells and three high-voltage cells along with 920 resistors and 28 programmable capacitors. Proto-

type wafers take three weeks. From \$17,000 for each.

Tektronix, ICO Marketing Dept, Box 500, Del Sta 59-420, Beaverton, OR 97077. Phone (503) 627-2515. Booth Nos 2504, 2506, 2508, 2510.

Circle No 603

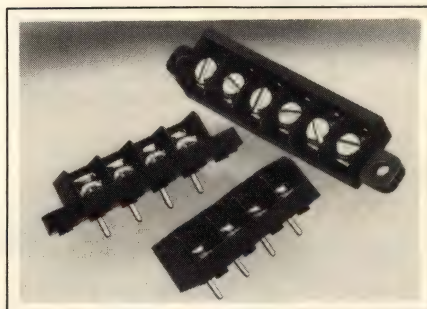


CERAMIC RESISTORS

The MPS/MPR Series ceramic insulated (wirewound or metal-oxide film) power resistors have radial, pronged leads. The leads enable heat transfer and stabilize the resistors when they're inserted into a pc board prior to soldering. The units are available in 3, 5, 7, 10, 15, and 20W power ratings with resistance ranging from 0.039 Ω to 150 k Ω at 5 to 10% tolerance. From \$0.14 (1000). Delivery, stock to 10 weeks ARO.

Robert G Allen Co Inc, 7267 Coldwater Canyon, North Hollywood, CA 91605. Phone (818) 765-8300. TLX 182699. Booth No 2258.

Circle No 604



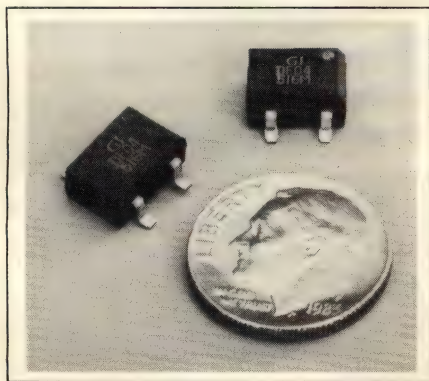
BARRIER STRIPS

Series 69000 pc-board terminal strips feature closed-side, single-row construction with terminals spaced on 0.325-in. centers. The contacts are rated at 20A. The

strips are UL recognized for field wiring. They measure 0.50 in. high and 0.60 in. wide and are interchangeable with the more expensive 4PCV and 4PCR Series. \$0.09/terminal. Delivery, three to five weeks ARO.

Vernitron Corp, Beau Products Div, Dept P5-7, Box 10, Laconia, NH 03247. Phone (603) 524-5101. Booth Nos 1210 and 1212.

Circle No 605



SMD BRIDGE

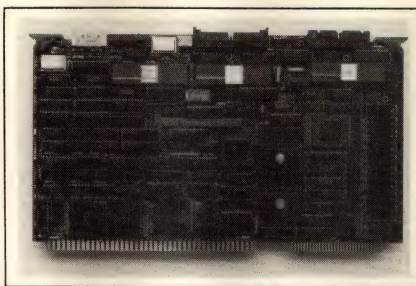
These single-phase, surface-mount bridges carry 1.0A and offer a surge-overload rating of 50A. The DF-S Series exceeds MIL-STD-19500 environmental standards. The plastic-cased devices are UL recognized. The line includes seven devices ranging from 50 to 1000V units. \$0.30 to \$0.50 (1000). Delivery, six to eight weeks ARO.

General Instrument Corp, Discrete Semiconductor Div, 600 W John St, Hicksville, NY 11802. Phone (516) 933-3333. Booth Nos 2162 and 2164.

Circle No 606

ETHERNET BOARD

The SBE/MLAN-11 is an Ethernet (IEEE 802.3) LAN interface board for Multibus systems. The board can function alone as a serial/parallel/SCSI gate to an Ethernet LAN, and it can also handle X.25 networks. The board has its own 10-MHz 68000 μ P, 128k or 512k bytes of RAM, and sockets for 256k bytes of EPROM. It also features a



68450 DMA controller for data transfers over the bus. It runs at full-duplex rates to 10M bps. Optional modules handle iSBX electrical interfaces and protocols. \$1495 (100).

SBE Inc, 2400 Bisso Lane, Concord, CA 94520. Phone (415) 680-7722. TWX 910-366-2116. Booth No 1076.

Circle No 608



JOYSTICK

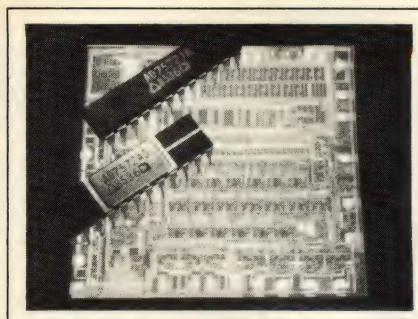
The Challenger is a dual-axis, solid-state control stick that provides a linear output in both the X and Y axes. The joystick has no potentiometers and features a below-panel depth of less than $\frac{3}{4}$ in. The joystick has 27° of movement from its center position. The handle has a spring return to center position. \$41.43.

Bolt Industrial Controls Inc, 4645-2F Industrial St, Simi Valley, CA 93063. Phone (818) 716-5159. Booth No 376.

Circle No 607

12-BIT CONVERTER

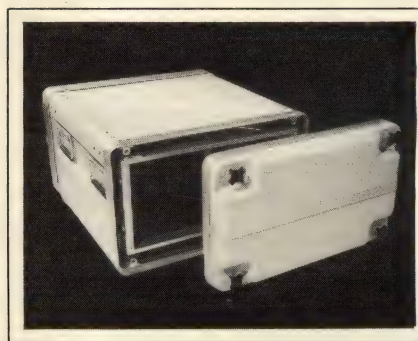
The AD7572 is a CMOS, 12-bit A/D converter that exhibits a 5- μ sec



max conversion time. The chip consumes 215 mW max and includes an on-chip zener voltage reference. A less-expensive, 12.5- μ sec version is also available. The AD7572 comes in a 0.3-in.-wide, 24-pin DIP or 28-pin LCC. Maximum data-address time is 70 nsec and maximum bus-relinquish time is 40 nsec. Three-state outputs and an internal latch allow a μ P to read data in either 12-bit parallel format or 8 $\times$ 4-bit format. Depending on grade, the 5- μ sec version costs \$47 to \$197.50; the 12- μ sec version, \$35 to \$145 (100).

Analog Devices Literature Center, 70 Shawmut Rd, Canton, MA 02021. Phone (617) 935-5565. TWX 710-394-6577. Booth Nos 206, 208, 307, and 309.

Circle No 610



TOUGH CASES

These transportable cases protect electronic equipment from shock, vibration, and environmental hazards while transporting and operating the equipment. The cases of the 5500 Series are built to EIA-RETMA dimensions and constructed from pressure-molded fiberglass. They feature 8-point, elastomeric shock-mounted, aluminum inner frames and standard re-

FROM THE FIRST FAMILY OF GATE ARRAYS... A PROUD, NEW ADDITION

I can remember when it all began at Hughes in 1979. With a single metal HCMOS 1000-gate array. Since then the Hughes family of military gate arrays has grown. In 1985 the 2 micron ($I_{eff} = 1.2$ microns), double metal U-series of channelless gate arrays was born, descended from the broadest, high performance line of HCMOS arrays in the semiconductor industry.

And now, our latest arrival, the alternate sourcing of LSI Logic Corporation's entire military CMOS line: L5000, L7000 and L10,000 Series.

Meet the members of our family. We have one for every military application.

H-Series Array Family

Double metal HCMOS, $I_{eff} = 1.8$ microns, $t_{ox} = 500$ Å, clock frequency to 35 MHz. Five array sizes ranging from 1000 to 8000 equivalent gates.

V-Series Array Family

Double metal HCMOS, $I_{eff} = 1.2$ microns, $t_{ox} = 300$ Å, clock frequency to 50 MHz. Five array types ranging from 1000 to 8000 equivalent gates.

U-Series Array Family

Double metal HCMOS II, $I_{eff} = 1.2$ microns, $t_{ox} = 300$ Å, clock frequency to 100 MHz. Ten channelless array types with 1000 to 41,000 gate complexities. Pin counts to 256. Each output drive capability of 7 TTL loads.

Joe Angleton, assistant laboratory manager for VLSI design at the Missiles System Group, is a primary originator of Hughes gate array efforts.

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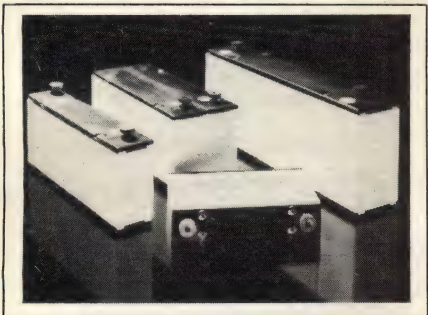
CIRCLE NO 90

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Booths 1516 & 1518

cessed hardware. Rack heights range from 5.25 to 21 in. The line is also available in a variety of colors. \$1042 to \$1448.

Environmental Container Systems Inc, 3560 Rouge River Hwy, Grants Pass, OR 97526. Phone (503) 476-8871. TWX 510-755-0777. Booth Nos 2127 and 2129.

Circle No 613



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Avex Electronics Corp, Portable Battery Div, Box 1026, Bensalem, PA 19020. Phone (215) 638-1515. Booth No 580.

Circle No 612

TOOL KIT

The JTK-87L3 tool kit for field engineers features both metric and regular tools. It contains more than 100 tools, including pliers, wrenches, optical aids, nut drivers, wire strippers and cutters, and soldering equipment. The kit also includes three removable pallets: The two



gate-swing top pallets hold the regular, inch-measure tools, and the bottom pallet contains the metric tools. You can choose from three cases: wood and vinyl, injection molded, and polyethylene. Wood/vinyl and injection-molded wood cases, \$549; polyethylene version, \$599.

Jensen Tools Inc, 7815 S 46th St, Phoenix, AZ 85040. Phone (602) 968-6241. Booth No 483.

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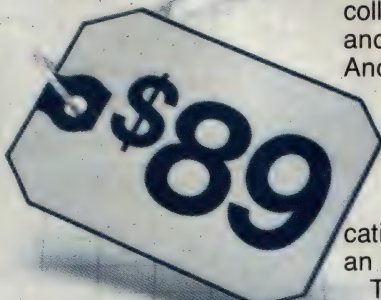
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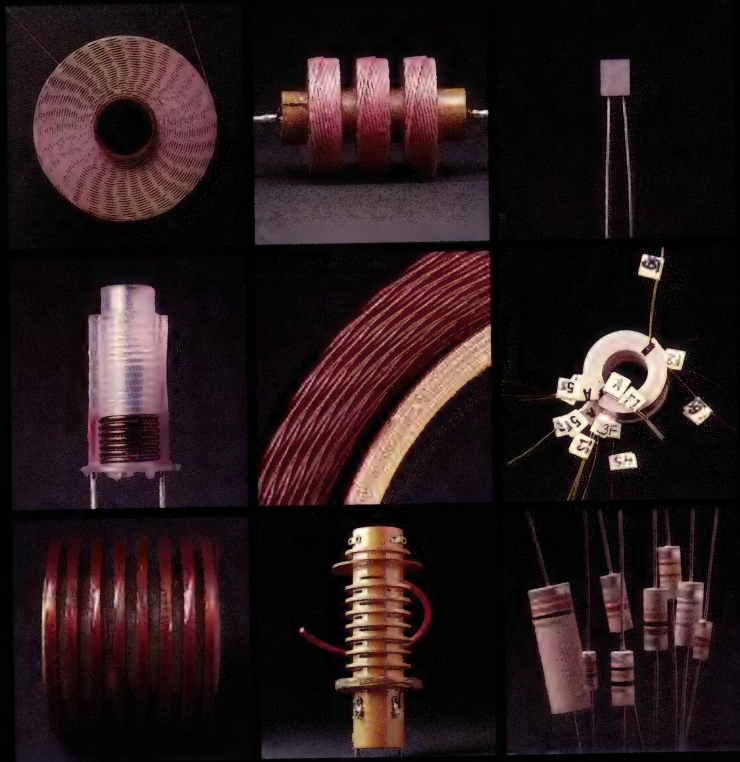


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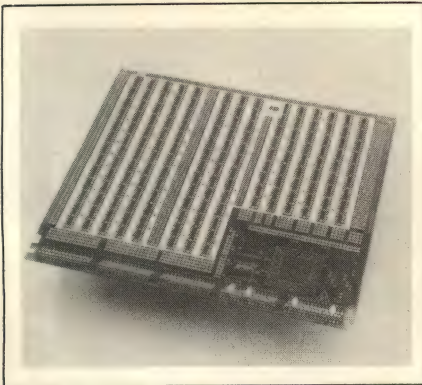
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Ives Road, Wallingford, CT 06492. (203) 269-8701.

CIRCLE NO 93

EDN May 1, 1986



VAX PROTOTYPE BOARDS

Each member of this series of prototype boards fits DEC's new VAXBI bus and employs 10-layer construction in its BI portion and wrapped-wire pins in the remainder. The boards include pin patterns for both DIPs and PGAs. Some panels come with SMD decoupling capacitors. The first panel in the series (8136-DECVI-10-2TG) is available now. \$895.

Augat Inc, Systems Div, 40 Perry Ave, Attleboro, MA 02703. Phone (617) 222-2202. TWX 710-391-0644. Booth Nos 1462 to 1469.

Circle No 611

DIP RELAY

The HAS 111 Series 1A relays are available semisealed or sealed; the sealed unit is filled with nitrogen for longer contact life. The series offers both standard and sensitive coil-resistance versions over the 4 to 48V input-voltage range. Both units can meet FCC Part 68 standards if necessary. Maximum switching voltage is 60V dc/120V ac, and switching power is 30W dc/60 VA ac. The units measure 0.62×0.43×0.44 in. \$0.59 (1000).

Hasco Components Inc, 247-40 Jericho Tpk, Bellerose Village, NY 11001. Phone (516) 328-9292. TWX 710-582-5750. Booth No 339.

Circle No 616

DIGITAL METERS

The PM Series of digital panel meters includes eight models, including a 3-digit version with LED indicators. Also included are four

3½-digit models featuring either LED or LCD readouts. A 4-digit model and two 4½-digit devices come with LED indicators. The meters come in standard enclosures. \$63 to \$224.

Non-Linear Systems, Box N, Del Mar, CA 92014. Phone (619) 481-3900. TLX 249045. Booth Nos 2217, 2218, and 2219.

Circle No 617

DUAL-BEAM SOCKETS

Series 802 dual-beam DIP sockets are now available in 24-pin, 0.300-in.-center and 48-pin, 0.600-in.-center models. The sockets feature face-wipe contacts, a closed bottom, side stackability, and a 40° target angle for entry of device leads. They are compatible with automatic-insertion equipment. The devices come in several contact-material

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 Output Level: +13 to -137 dBm
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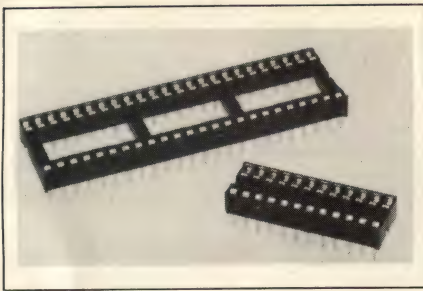
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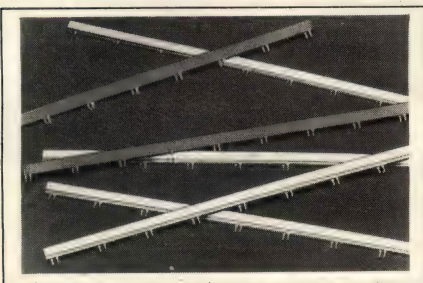




and plating options. The socket body is block polyester with a UL 94V-O rating. \$0.096 (OEM qty) for a tin-plated, phosphor-bronze, 24-lead socket on 0.300-in. centers.

Wells Electronics Inc, 1701 S Main, South Bend, IN 46613. Phone (219) 287-5941. Booth No 1470.

Circle No 615



PC-BOARD STIFFENER

This dual-conductor pc-board stiffener reinforces pc boards that would otherwise have a tendency to warp or bow. The stiffeners have dual metal buses for V_{CC} and ground. The stiffeners are made from tin-plated copper. \$1.15 to \$2.25, depending on length. Delivery, six to eight weeks ARO.

Bussco Engineering Inc, Box 707, El Segundo, CA 90245. Phone (213) 322-6580. TWX 910-348-6295. Booth No 2755.

Circle No 618

I/O MODULE SOCKET

The OS 1 pc-board socket accepts all standard I/O modules and mounts directly onto a pc board. It features a snap-in hook to latch modules that don't have mounting screws. The socket is available separately or as part of a 1-, 4-, or 8-way rail-

mounted assembly, which features plug-in fuses and LEDs. Screw-clamp terminals for field wiring both the OS 1 socket and the complete assemblies are rated for 250V ac, 5A per channel. \$233.20 (100).

Weidmüller Terminations Inc, 821 Southlake Blvd, Richmond, VA 23236. Phone (804) 794-2877. TLX 828376. Booth No 1433.

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The Jewel surge suppressor protects electronic equipment from electrical spikes and surges. The suppressor's metal-oxide varistor (MOV) can dissipate 150J, which is almost twice the amount dissipated by comparable suppressors, according to the manufacturer. The UL-listed device offers protection in both common and normal modes and

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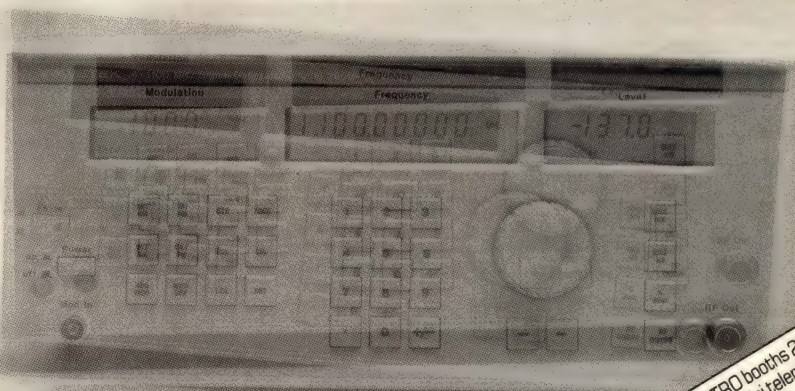
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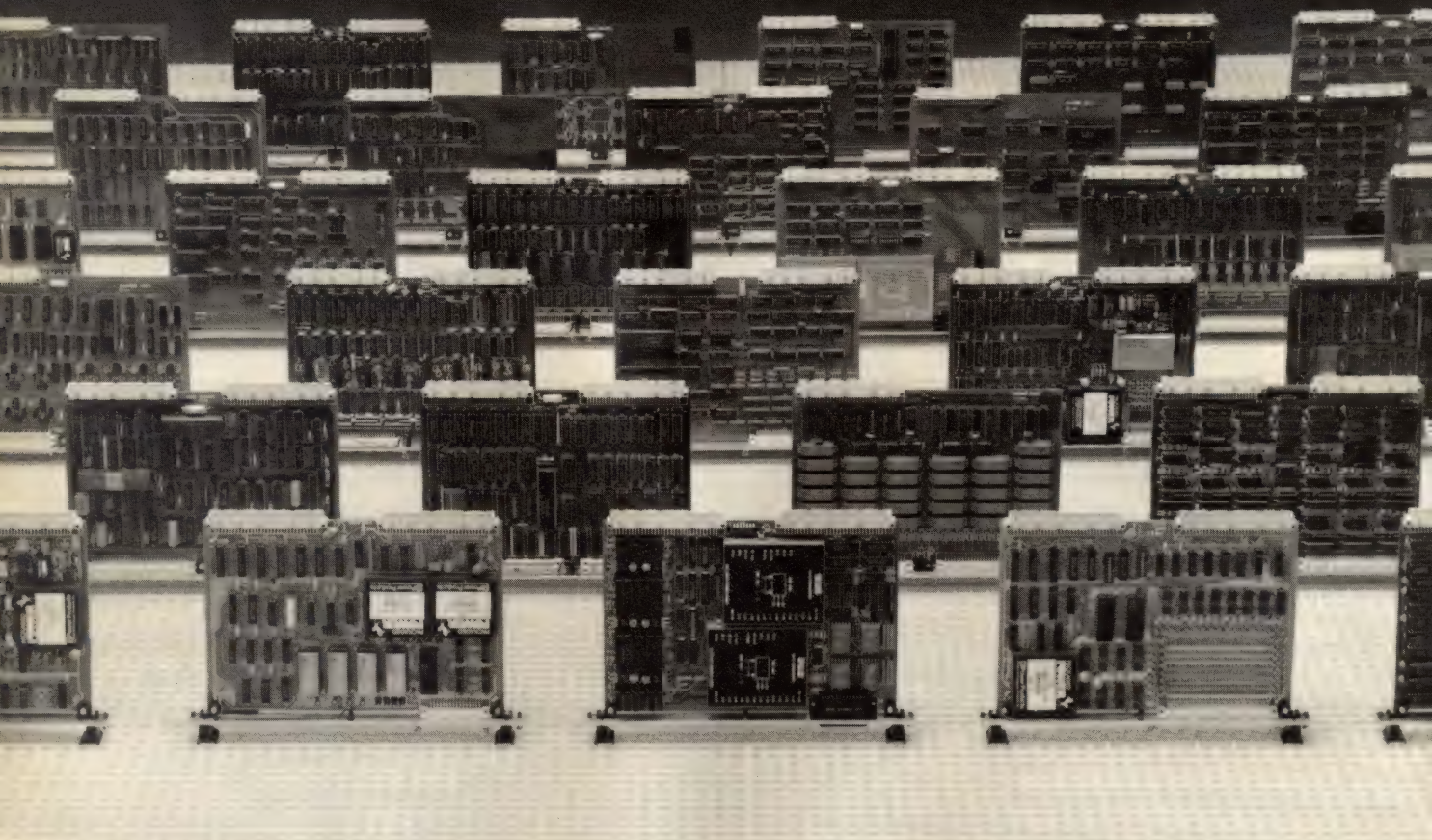
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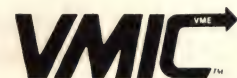
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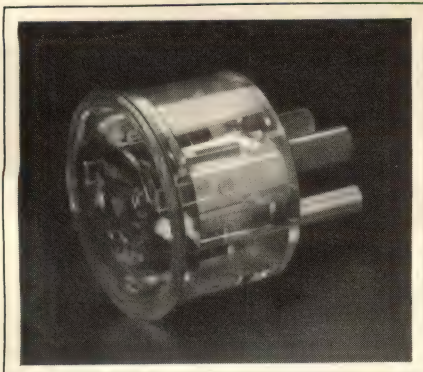
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Wago Corp, 6657 N Sidney Pl, Milwaukee, WI 53209. Phone (414) 352-1035. TLX 260123. Booth No 2566.

Circle No 621

LEDs

Series 4310H1 bare LED indicators produce 1000 mcd when energized with 20 mA. At 50 mA, the LEDs emit more than 2000 mcd. The de-

vices come in T-1 $\frac{3}{4}$ clear packages. Light output is red; the LEDs' viewing angle is 12°. Typical forward voltage is 2.0V, and minimum reverse breakdown voltage is 4.0V. \$1.78 (1000).

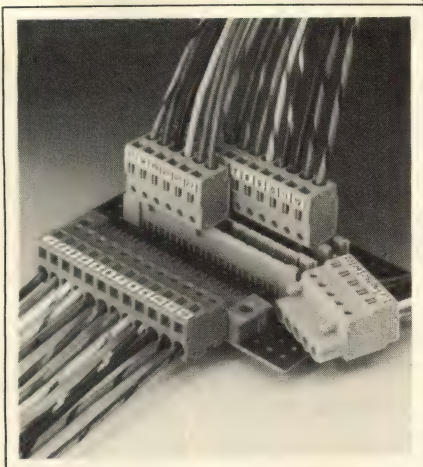
Industrial Devices Inc, 7 Hudson Ave, Edgewater, NJ 07020. Phone (201) 224-4700. Booth Nos 2163, 2165, and 2167.

Circle No 619

plugs into one receptacle in a duplex outlet, thereby protecting devices plugged into adjacent receptacles. The Jewel meets IEEE-587 requirements. \$20.

Tyton Corp, 7930 N Faulkner Rd, Milwaukee, WI 53223. Phone (414) 355-1130. TWX 910-262-3094. Booth Nos 437 and 439.

Circle No 623



PC-BOARD CONNECTOR

This 2-piece connector for pc boards comes with a straight or right-angle pin header. The connector's pins are tin-plated. The header accepts a polarized, latched plug. The connectors are available with pins on 5-mm or 0.2-in. centers. The plugs accept solid or stranded AWG 24 to 14 wire. The header has either 1-mm² pins (10A rating) or 1.2-mm² pins (15A UL and CSA). The pins are long enough for 0.15-in.-thick pc boards. You can attach field wiring from the front of the connector; each pin also has a test jack. Approximately \$0.62 per through hole.

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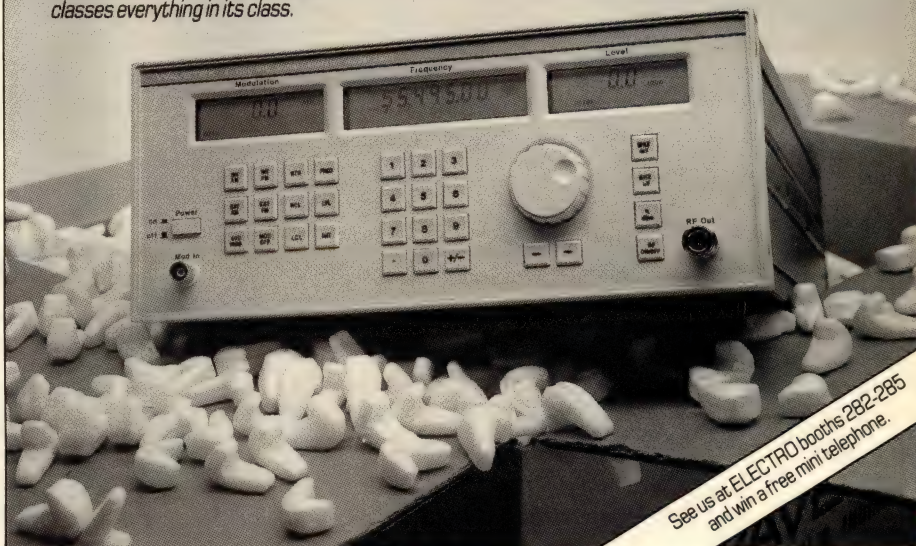
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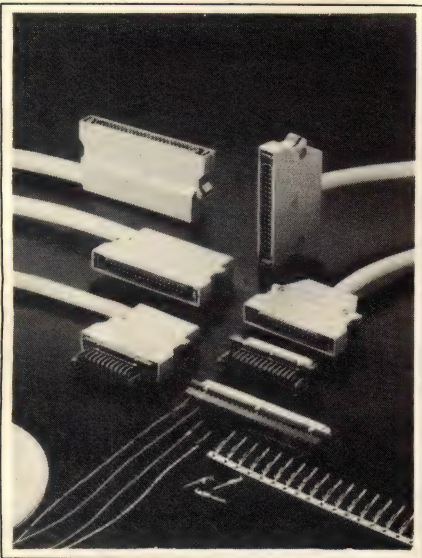
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Hirose Electric USA Inc, 9254 Deering Ave, Chatsworth, CA 91311. Phone (818) 709-1247. TWX 910-494-2199. Booth No 2967.

Circle No 609

SMD TRIMMERS

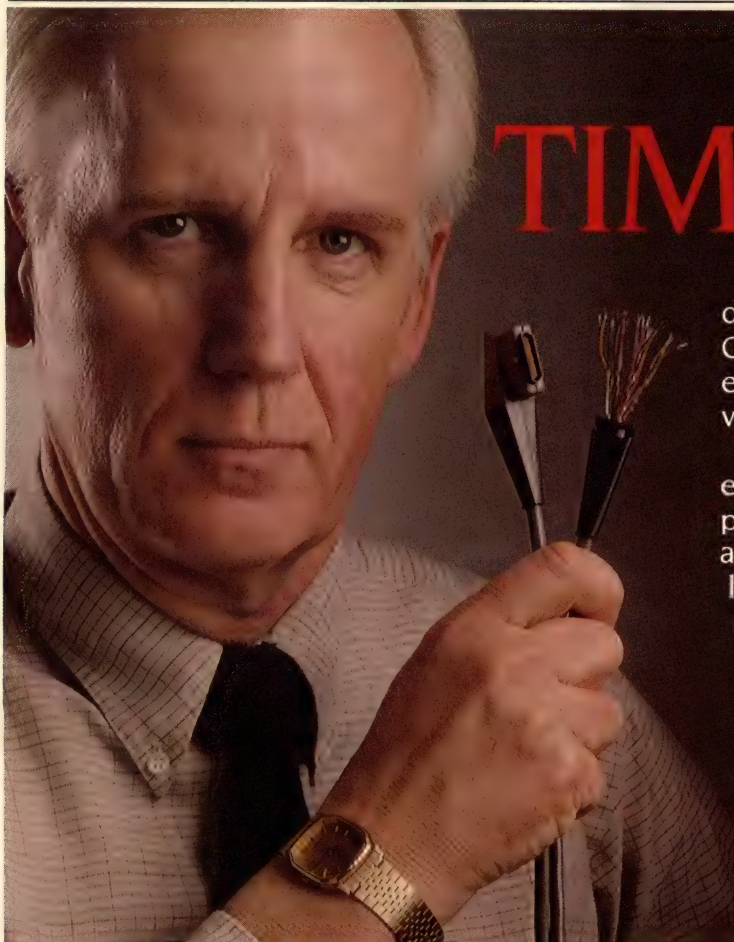
TMC4K Series surface-mount trimming potentiometers feature a ceramic substrate, a metal-glaze element, and an insulated adjustment knob. An adhesive can hold the TMC4K to a circuit board for reflow soldering without ill effect on the potentiometer's operation. Unlike other potentiometers, which have in-line footprints, the devices have a triangular footprint for greater stability. The trimmers can withstand operating temperatures of -30 to +100°C and can handle as much as



0.2W at 20V. Standard resistance range is 200Ω to 1 MΩ. Outside dimensions are 0.15×0.18×0.08 in. \$0.135 (10,000).

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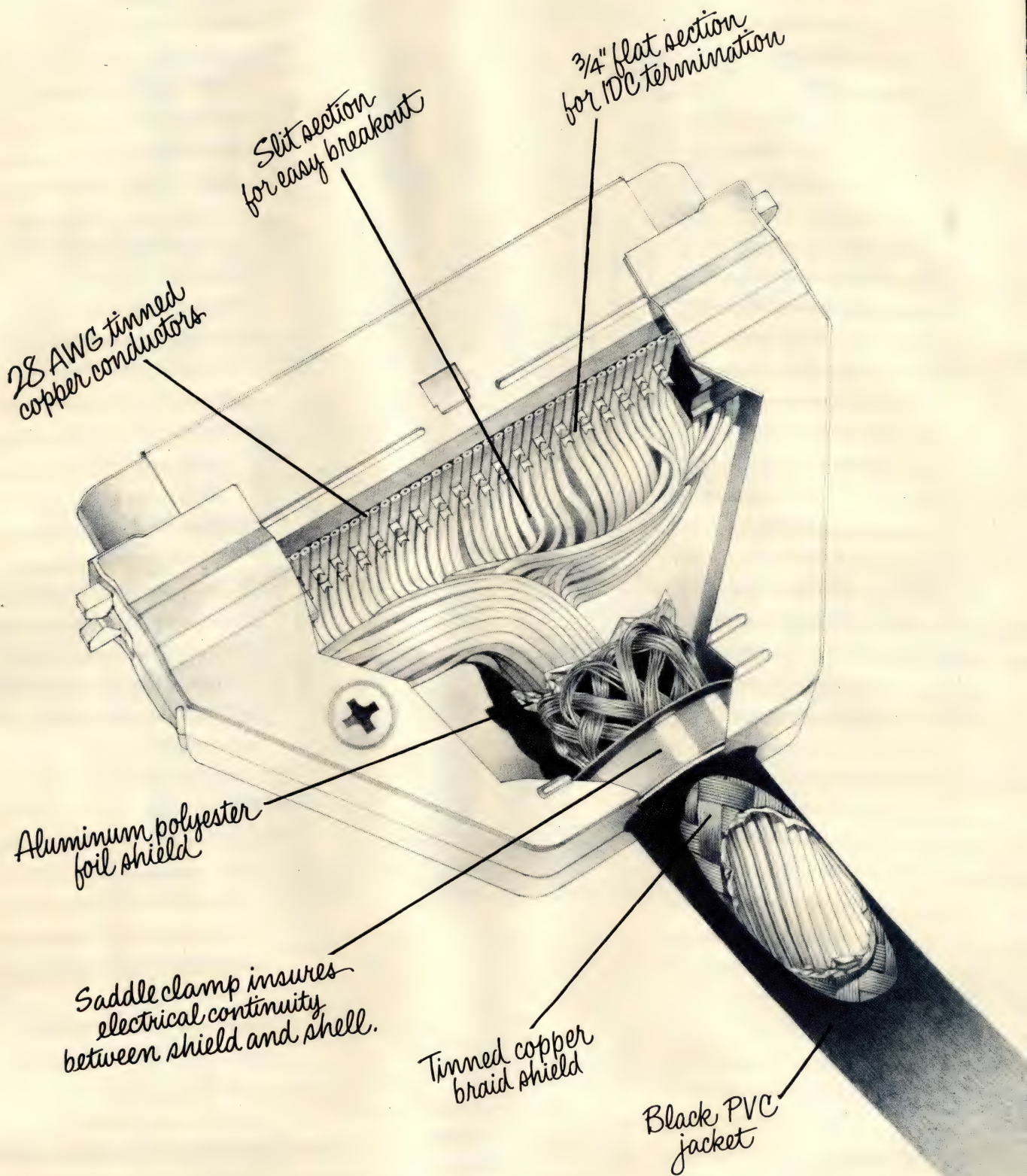
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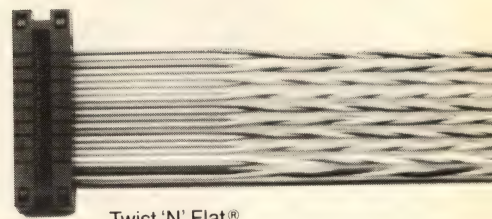
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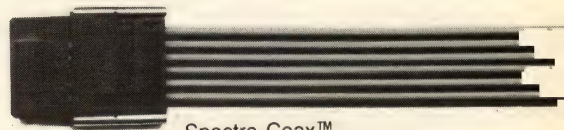
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Low-cost buses add industrial I/O to VME, Multibus II

Links to an 8- or 16-bit I/O subsystem prove a cost-effective solution to providing data-acquisition and industrial-control interfaces for VME and Multibus II systems. This article describes cards that you can link in an I/O subsystem bus.

Peter Harold, *European Editor*

If you're planning to interface your VME Bus or Multibus II computer system to a large number of transducers or control devices, you may find that the cost of providing the necessary I/O functions with VME Bus- or Multibus II-compatible boards (see EDN, March 6, pg 191) is prohibitive. Such I/O operations, however, rarely require the 32-bit-wide or high-speed data transfers that the main system buses are designed to handle. To provide the required I/O functions economically, consider using an 8- or 16-bit subsystem bus that communicates to the VME Bus or Multibus II system via a suitable linking card. This strategy can simplify mechanical construction and support function-

al partitioning of the system software. You can also cut your software-development costs by controlling the I/O cards with standard operating-system kernels and device drivers.

The 16- and 32-bit data pathways, high-speed memory access, and multiprocessor capabilities of VME Bus and Multibus II systems allow you to build Eurocard-based computer systems that can execute, in real time, the complex data-analysis and process-control algorithms required by today's industrial-control and monitoring systems. However, because the ability of these algorithms to correctly model and thus control a process requires the collation of a great deal of information, the computer must often link with a large number of process transducers through A/D converters and signal-switching matrices. On the other side, the need for adequate control capabilities may demand that the system interface to a variety of output devices—for example, D/A converters, relay drivers, solid-state switches, and motor controllers.

As a consequence, you might not be able to satisfy your I/O requirements with a single VME or Multibus II board, and you may suddenly find that the cost of several such boards is greater than you profitably can bear. The high cost of VME Bus and Multibus II boards lies partly in their double-height Eurocard size and partly in the interface logic required on each board to

Instead of using expensive 32-bit VME or Multibus II I/O boards, you can reduce the cost of your I/O functions by implementing them on a simple 8- or 16-bit bus.

couple it with the high-performance backplane. You can reduce the cost of your I/O functions by implementing them on a simpler 8- or 16-bit, Eurocard-based bus, which you can integrate into your VME Bus or Multibus II design as an I/O subsystem. (See the tables beginning on pg 186 to find out more about available subsystem-bus boards.)

Adopting the subsystem approach has a number of advantages. Because most of the industrial-I/O cards for these 8- and 16-bit subsystem buses come on single-height Eurocards, they're more modular than corresponding double-height Eurocards. This modularity makes it easier to choose boards that closely match the I/O requirements of your system so that you won't be paying for functions you don't require. Even on a function-for-function basis, boards for the subsystem bus are in general considerably cheaper than those designed to the VME Bus or Multibus II specification, because of their smaller pc-board size and simpler bus-interface logic. Depending on the level of processing you require, you can choose between an 8-bit bus

such as the STE Bus or Eurobus, or a 16-bit bus such as the G64 Bus or the AMS Bus.

Tables 1 and 2 list specifications of the 8- and 16-bit buses that you can integrate into the same card cage as a VME Bus or Multibus II system. It's easy to install the appropriate linking card and the two required backplanes in your card cage; most linking cards are double-height Eurocards, with the VME Bus or Multibus II interface on their upper P1 connector and the subsystem bus interface on their lower P2 connector. You simply overlap the backplanes by one slot position so that the linking card plugs into both (**Fig 1**).

Some of the I/O boards and linking cards differ in depth. Multibus II boards, for example, come on 220-mm-deep Eurocards, while the I/O bus best suited to Multibus II, the AMS Bus, is implemented on 160-mm-deep Eurocards. This variance should occasion no worry: It's much easier to accommodate depth variations in a Eurocard enclosure than it is to accommodate boards that don't conform to Eurocard height specifications. In fact, when the I/O subsystem bus cards are

TABLE 1—SUBSYSTEM BUSES FOR VME BUS SYSTEMS

SUBSYSTEM BUS	DATA TRANSFERS (BITS)	TRANSFER SPEED (BYTES/SEC)	SYNC/ASYNC	ADDRESS RANGE		NUMBER OF INTERRUPT LINES	MULTIPROCESSOR SUPPORT
				MEMORY	I/O*		
DYBX BUS	16	1.6M	ASYNC	16M BYTES		4	YES
G64 BUS	8, 16	10M	SYNC/ASYNC	2 × 64k WORDS	1k WORD	3	NO
II/OC/EUROBUS	8	2M	SYNC/ASYNC	1M BYTE		3	YES
BSB BUS	8	1M (APPROX)	ASYNC		128 BYTES	2	NO
MIOS BUS	8, 16	8M (APPROX)	ASYNC	64k WORDS		3	YES
MOTOROLA I/O CHANNEL	8	2M	ASYNC		4k BYTES	4	NO
STE BUS	8	5M	ASYNC	1M BYTE	4k BYTES	8	YES

*ADDITIONAL I/O MUST BE MEMORY MAPPED.

TABLE 2—SUBSYSTEM BUSES FOR MULTIBUS II SYSTEMS

SUBSYSTEM BUS	DATA TRANSFERS (BITS)	TRANSFER SPEED (BYTES/SEC)	SYNC/ASYNC	ADDRESS RANGE		NUMBER OF INTERRUPT LINES	MULTIPROCESSOR SUPPORT
				MEMORY	I/O*		
AMS-M BUS**	8, 16	10M	ASYNC	16M BYTES	64k BYTES	8	YES
SMP BUS	8 (16 EXPANSION)	8M	SYNC	1M BYTE	256 BYTES	2	NO
ECB BUS	8	1M	SYNC	8 × 64k BYTES	256 BYTES	2	NO
EUROLOG BUS	8	1M	SYNC	8 × 64k BYTES	256 BYTES	2	NO

*ADDITIONAL I/O MUST BE MEMORY MAPPED.

**PARALLEL BACKPLANE FOR THE AMS BUS SYSTEM.

shorter than the main computer cards, you have some extra space within the enclosure for the signal cables often associated with industrial-I/O systems.

The bus you choose must be compatible with your overall system architecture, and a suitable linking card must implement that architecture across the interface between the VME Bus or Multibus II system and the I/O subsystem bus. Linking cards fall into three categories: protocol converters, dual-port RAM cards, and CPU-based cards on the main system.

Protocol converter for similar buses

Protocol-converter cards usually have hardware logic to transform the signal lines and timing specs of one bus structure into those of another. They therefore tend to link only bus structures that have similar characteristics—for example, bus structures with nonmultiplexed and asynchronous data transfers. Dual-port RAM cards contain memory that connects on one side to the VME Bus or the parallel system bus (iPSB) of Multibus II and on the other side to the subsystem bus. You

transfer data from one bus to the other using the dual-port RAM as a mailbox facility. Software-pollled semaphores or interrupts let the receiving bus know that a message is waiting.

The protocol-converter and dual-port RAM cards usually also include a means of transferring interrupts from the subsystem bus to the main system bus. CPU-based linking cards, which are essentially processors on the main system bus, configure the subsystem bus as a local CPU resource and allocate a portion of the CPU's memory map to the subsystem bus. Usually, only the CPU card's onboard μ P can access the subsystem bus.

If you're using the subsystem bus simply to link low-cost, unintelligent slave cards in a single-processor VME Bus or Multibus II system, then a CPU-based linking card will provide the system CPU and the interface to the subsystem bus. If you add other CPUs to the main system bus to produce a multiprocessing, functionally partitioned system, you can dedicate the linking card's CPU to I/O-subsystem control. The CPU-

DMA SUPPORT	BUS ERROR SIGNAL	EUROCARD SIZES	AVAILABLE CPU SUPPORT	AVAILABLE LINKING CARDS (MANUFACTURER: MODEL NUMBER)
YES	YES	—	DEDICATED I/O BUS FOR DY-4'S SVME-101 CARD	DY-4: SVME-101
YES	YES	SINGLE-HEIGHT	32016, 6800, 6802, 6809, 68000, 68010, 8085, 8088, 80286, J11, Z80	THOMSON: TSVME101 SYNTEL: SYN-VM020
YES	YES	SINGLE-HEIGHT	6502, 6800, 6802, 6805, 6809, 68008, 8085, 80C88, Z80	PEP: VI/OC DORSCH: VME1-CPU
NO	YES	SINGLE-HEIGHT	68008	PHILIPS: PG2911
YES	YES	DOUBLE-HEIGHT	2650	PHILIPS: PG2910
NO	NO	SINGLE-HEIGHT	DEDICATED I/O BUS FOR 68000-BASED VME BUS SYSTEMS	MOTOROLA: MVME316, MVME-110-1 DUAL SYSTEMS: VI/OP
YES	YES	SINGLE/DOUBLE-HEIGHT	32008, 32016, 6809, 68008, 64180, 65816, 68HC11, 8085, 80188, NSC800, Z80	PERFORMANCE INTERCONNECT: S10014, S10013-1, S10013-2

DMA SUPPORT	BUS ERROR SIGNAL	EUROCARD SIZES	AVAILABLE CPU SUPPORT	AVAILABLE LINKING CARDS (MANUFACTURER: MODEL NUMBER)
YES	NO	DOUBLE-HEIGHT	8085, 8086, 80186, 80286	SIEMENS: TO BE ANNOUNCED
YES	NO	SINGLE-HEIGHT	8031, 8080, 8085, 8088, 80188	SIEMENS: VIA AMS BUS CPU OR DPR AND LINKING CARD
YES	NO	SINGLE-HEIGHT	Z80	FURRER-GLOOR: MB2/LNK-1
YES	NO	SINGLE-HEIGHT	64180, 8080, Z80	FURRER-GLOOR: MB2/LNK-1

Choosing a suitable subsystem bus depends on I/O requirements, system architecture, and the availability of a card that interfaces to the main system bus.

based linking architecture is also suited to systems that require very fast I/O-interrupt servicing, because you can send interrupts from the I/O subsystem directly to the linking card's μ P and respond to them without the overhead of interrupt and bus-arbitration cycles on the VME Bus or the Multibus II iPSB. The I/O processor may also be able to perform some data compression through preprocessing of the acquired data.

Addition of CPUs requires arbitration

Some of the subsystem buses that have attracted a substantial following—for example, the STE Bus, which is currently being studied by IEEE working group P1000—are not supported by a CPU-based linking card. You may still be able to accommodate these buses using a protocol-converter card, which allows slave I/O boards to appear as if they're located on the main system bus. Either way, if you want to add CPUs to the subsystem bus, the subsystem bus must have arbitration logic to support multiple bus masters, or it must be able to support DMA transfers. Bus arbitration or DMA capability is necessary because both the subsystem bus's CPUs and the main system's CPUs must be able to access a mailbox area in the subsystem's memory in order to communicate with one another.

Dual-port RAM cards link processors on either side of the linking card without the requirement for bus arbitration on the subsystem bus. The RAM's own arbitration logic resolves conflicts between the main and subsystem buses when they try to gain access to the RAM simultaneously. Only if the subsystem bus itself contains multiple processors does it then require bus-arbitration capabilities.

It's unlikely that a CPU-based linking card's processor will be anything other than a 68000 family μ P on a VME Bus board, or an Intel iAPX family processor on a Multibus II board. One advantage of using a protocol-converter or dual-port RAM card is that the subsystem bus can operate with a variety of main-system processor types. At least 10 different μ Ps, for example, support the STE Bus when it is appropriately connected. If you already have valuable experience in implementing industrial-I/O systems with one or more of these μ Ps, you only need to add a message-passing protocol for communication to the VME Bus.

Protocol-converter and dual-port RAM links have another advantage: They allow any bus master in the main system to access devices on the I/O subsystem bus through the linking card's slave interface. This unrestricted access from the main-system bus suits the

associated I/O boards for use in fault-tolerant multiprocessor systems, in which any of the main system's CPUs might have to undertake system-level control of the I/O processes.

Available VME Bus linking cards allow you to build I/O subsystems based on the STE Bus, the Eurobus, and various proprietary buses. For example, the \$395 S10014 VME/STE protocol converter from Performance Interconnect Inc maps the full 1M-byte STE Bus memory-addressing range into a 1M-byte block of VME Bus address space. It allows 8-bit access to STE Bus memory using standard supervisory program/data and standard nonprivileged program/data VME Bus transfers. The 4k bytes of STE Bus I/O space is similarly mapped into a 4k-byte block of VME Bus memory and is accessible using the VME Bus's short-supervisory and short-nonprivileged I/O-access addresses.

The board also combines the eight attention-request lines of the STE Bus into a single VME Bus interrupt, to which you can assign any one of the seven VME Bus interrupt levels. If the STE Bus interrupt is explicit (ie, the interrupting source provides its own interrupt vector), the bus vector passes through to the VME Bus. If, however, the STE Bus interrupt is implicit (ie, the interrupt source provides no vector), then software-programmable registers on the protocol-converter card automatically provide an interrupt vector. If your system includes several CPUs on the STE Bus, the S10014's bus arbiter will settle conflicts arising from simultaneous attempts to control the bus.

Performance Interconnect also offers a dual-port RAM linking card. The \$895 S10013-1 VME/STE link places an 8-MHz 68008 μ P on the STE Bus side of the link, and it uses 64k bytes of onboard, dual-port RAM for data and program exchange between the VME Bus and the STE Bus. The RAM connects to the VME Bus via the board's P1 connector. The connection acts as an A24/D16/D8 VME Bus slave interface that transfers standard supervisory programs and data and standard nonprivileged programs and data. Access to the RAM's second port is via the onboard 68008 μ P, which operates through the board's P2 connector as an STE Bus default master. The μ P furnishes 512k bytes of dynamic RAM and 64k bytes of EPROM firmware space.

The STE Bus interface includes an STE Bus interrupt handler for both implicit and explicit interrupts. It also contains system-controller functions, which include the generation of SYSCLK* and SYSRST* from the corresponding VME Bus signals, and user-selectable DACK* timeouts. The 68008 μ P generates inter-

rupts to the VME Bus on any one of the seven interrupt levels. The μ P also provides a software-programmable 8- or 16-bit interrupt vector. When your STE Bus I/O subsystem is a multiprocessor subsystem, the S10013-1 board's STE Bus arbiter designates the 68008 μ P as the STE Bus default master, granting it STE Bus access whenever the bus is not in use by another master. For \$795, the board is also available as the S10013-2, with 128k bytes of local RAM and 16k bytes of dual-port RAM.

Protocol converter for Eurobus I/O

PEP Modular Computers' VI/OC protocol converter card links the VME Bus with the company's 8-bit II/OC/Eurobus (intelligent-I/O-channel Eurobus) by mapping II/OC/Eurobus slaves into a 64k-byte memory block within the VME Bus memory map. One end of the single-Eurocard VI/OC board has a VME Bus interface, and the other end links with the II/OC/Eurobus backplane via ribbon cable, which can be 50 cm long. The VI/OC can transfer 8- or 16-bit data to and from the

VME Bus, because the card has the necessary logic to reformat two 8-bit bytes into a 16-bit word. The II/OC/Eurobus also supports multiple bus masters, so each time the VME Bus transfers data to an II/OC/Eurobus slave device, it does so by requesting a low-priority DMA operation on the II/OC/Eurobus. The VI/OC costs DM 590.

If you choose to implement local subsystem CPUs with either Performance Interconnect's or PEP Modular Computers' linking cards, note that neither card gives subsystem bus masters direct access to VME Bus slaves. The easiest way to effect communication from the subsystem bus to the VME Bus side of the link is to allocate a block of memory on the subsystem bus as a mailbox area and to use the linking card's interrupt capability or software-pollled semaphores to indicate that a message is waiting. Performance Interconnect's S10014 protocol converter maintains the indivisibility of read-modify-write operations across the VME Bus to STE Bus interface, specifically to maintain the integrity of such semaphores.

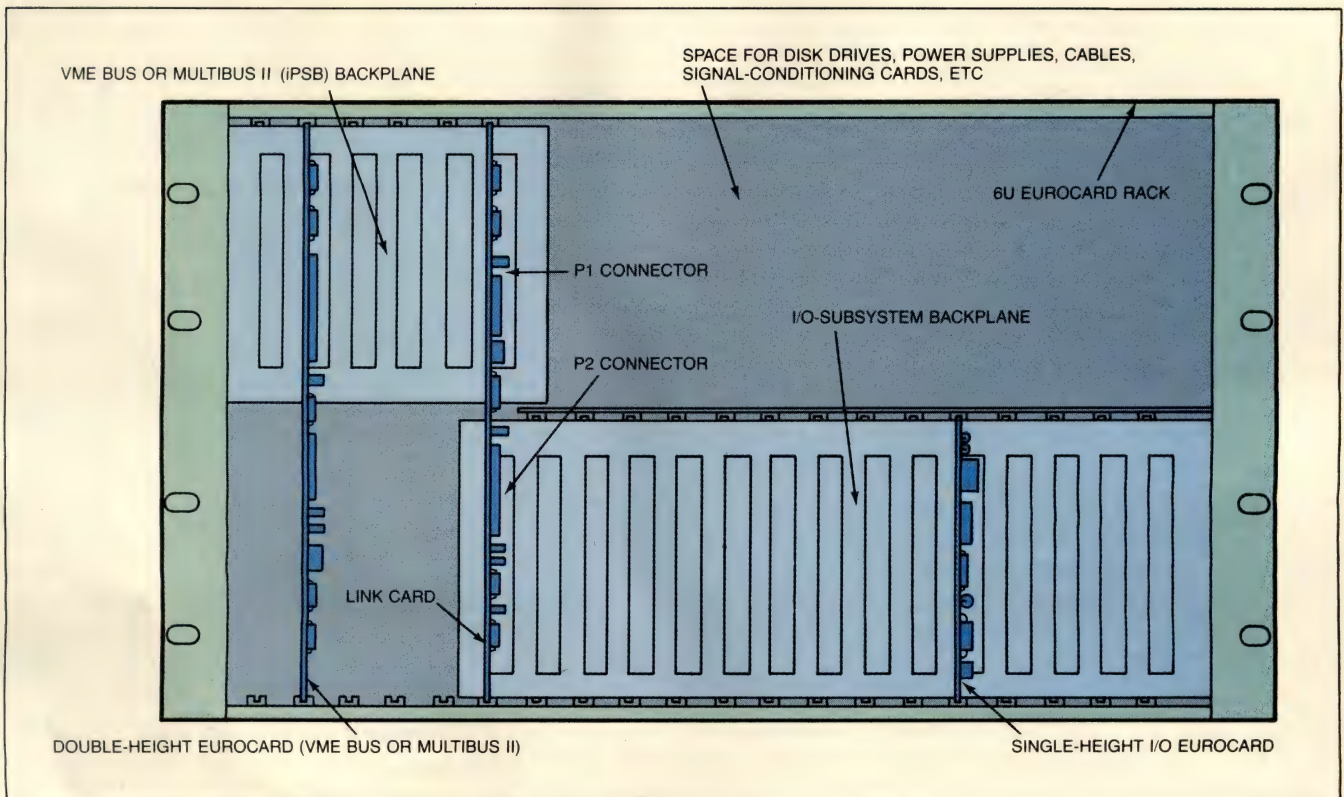


Fig 1—To connect an I/O subsystem with a VME Bus or Multibus II system, overlap the backplanes of the subsystem and your main system bus by one slot. The appropriate linking card, typically a double-height Eurocard, interfaces with the main-system bus on the upper P1 connector and with the subsystem bus on the lower P2 connector.

One advantage to using a protocol-converter or dual-port RAM card is that the subsystem bus can operate with a variety of main-system processor types.

Another card linking the VME Bus to the Eurobus comes from Dorsch Mikrosystems. The VME1-CPU card is a VME Bus-compatible, single-board computer with a Eurobus interface on its P2 connector. The Eurobus interface is supported by a DMA channel. The board costs DM 4500.

VME Bus links with proprietary systems

Motorola Inc's MVME316 protocol-converter board and MVME110-1 CPU card provide links between the VME Bus and the company's I/O Channel subsystem. The \$630 MVME316 maps the I/O Channel into 8k bytes of VME Bus short I/O address space, allowing 8-bit transparent access to I/O Channel slaves. In addition, the converter accepts interrupts from the I/O Channel's four interrupt lines and passes them to the VME Bus. For each of the four interrupts, you can program the desired VME Bus interrupt priority level and the corresponding interrupt vector that's provided during the VME Bus interrupt-acknowledge cycle.

The \$1295 MVME110-1 offers an alternative mode of connection. The CPU-based linking card configures the I/O Channel interface as a local resource, available only to the onboard 68000 μ P and occupying an 8k-byte block of its memory map.

With an onboard, 10-MHz 68000 μ P, as much as 128k bytes of ROM/EPROM, and 512k bytes of dual-port RAM (connecting the VME Bus to a 68000 μ P), the VI/OP I/O processor board from Dual Systems Corp provides a flexible link between the VME Bus and Motorola's I/O Channel. The \$1495 board's 68000 μ P gains access to the I/O Channel directly; VME Bus masters gain access to the subsystem via the board's A32/A24/D16 VME Bus slave interface. In addition, 16-bit read/write data passing to and from the 68000 μ P or the VME Bus is automatically multiplexed into two sequential 8-bit blocks for exchange with the I/O Channel, increasing the speed of block-data transfers.

The VI/OP can respond to interrupts from any of the four I/O Channel interrupt lines. It can also respond to three levels of interrupts from the VME Bus, and it can send interrupts to the VME Bus on any of the seven VME Bus interrupt levels. VME Bus masters can interrupt the 68000 by writing to a VI/OP register. At the same time, an interrupting master provides four bits of information to indicate the interrupt source or to provide an interrupt vector.

Philips uses protocol-converter cards to link its PC2300 and MIOS6 I/O subsystems to VME Bus systems. The buses for the 8-bit, single-height PC2300 and

16-bit, double-height MIOS6 cards are the BSB Bus and MIOS Bus, respectively. Like Motorola's I/O Channel, both these buses carry only I/O slaves when incorporated into a VME Bus system. The protocol-converter logic required to transform VME Bus signals into BSB or MIOS signals comes on Philips's PG2911 and PG2910 system-controller cards, respectively. These cards occupy slot 1 of the VME Bus system and provide bus-arbiter, ACFAIL*, SYSRESET*, SYSCLK, watchdog-timer, calendar-clock, and bus-error-indication functions, in addition to the subsystem-bus interface. A ribbon cable, which supports local expansion of the system to multiple racks, links the BSB Bus or MIOS Bus interface on the P2 connector of the system-controller cards to a bus-amplifier module inserted into the subsystem backplane.

To link a VME Bus system to Gespac's G64 Bus, Thomson Semiconductors' Microsystem Div offers the TSVME101 CPU card, which has a G64 Bus interface on its P2 connector. This interface provides 2k bytes of G64 Bus address space, accessible via the onboard 68000 μ P's local bus. Other local resources include eight 28-pin, byte-wide sockets for EPROM/RAM, two RS-232C serial interfaces, and three programmable counter/timers.

Syntel Microsystems also manufactures a CPU board with an interface to the G64 Bus on its P2 connector. The SYN-VM020 is based on a 68020 μ P and a 68881 math coprocessor. The board costs approximately £3000.

Another CPU-based linking card, the SVME-101 intelligent expansion card from DY-4 Systems, provides a link between the VME Bus and the company's 16-bit, asynchronous DYBX Bus. (You should only consider this bus if you're prepared to design your own custom I/O functions; currently, the DYBX Bus lacks I/O-board support.) The DYBX Bus is an extension of the bus structure of the SVME-101's onboard 68010 μ P. Although the DYBX Bus only appears as a 64k-byte window in the 68010's address map, paging registers provide eight additional address bits to utilize the bus's 24-bit addressing capabilities. To provide flexible communication between the buses, 128k or 512k bytes of available onboard RAM connect the 68010, the VME Bus, and the DYBX Bus. This architecture allows mailbox-type communication, via the RAM, between any DYBX Bus master and VME Bus masters other than the 68010.

In the future, watch for a new subsystem bus for VME Bus systems. The VSB Bus, based on a combination of the VMX Bus and Motorola's MVMX32 local-

Manufacturers of linking boards and subsystem I/O boards for the VME Bus and Multibus II

For more information on the linking boards discussed in this article and on subsystem I/O boards (such as those listed in the tables beginning on pg 186) for the VME Bus and Multibus II, contact the following manufacturers directly or circle the appropriate numbers on the Information Retrieval Service card.

Arcom Control Systems Ltd

Unit 8
Clifton Rd
Cambridge CB1 4BW, UK
(0223) 242224
Circle No 526

Control Vision Industries sa

44 chemin du Carriol
30380 St Christol-Les-Ales, France
(66) 609779
Circle No 527

Databeta Ltd

5 Chiltern Enterprise Centre
Station Rd
Theale
Berkshire RG7 4AA, UK
(0734) 303631
Circle No 528

Devlonics Control nv

Stasegemsteenweg 110
8500 Kortrijk, Belgium
(056) 202031
Circle No 529

Dorsch Mikrosystem GmbH

Hoeflas 14
8560 Lauf,
West Germany
(09123) 5583
Circle No 530

DSP Designs

c/o Dean Microsystems Ltd
7 Horseshoe Park
Pangbourne
Berkshire RG8 7JW, UK
(07357) 5155
Circle No 531

Dual Systems Corp

2530 San Pablo Ave
Berkeley, CA 94702
(415) 549-3854
Circle No 532

DY-4 Systems Inc

888 Lady Ellen Place
Ottawa, Ontario K1Z 5M1, Canada
(613) 728-3711
Circle No 533

EKF-Elektronik-Messtechnik GmbH

Weidekampstrasse 1a
4700 Hamm 1,
West Germany
(02381) 12630
Circle No 534

Furrer-Gloor AG

Elektronische Systemtechnik
Silbernstrasse 10
8953 Dietikon, Switzerland
(01) 7403585
Circle No 535

Gespac sa

3 chemin des Aulx
1228 Geneva/Plan-les-Ouates
Switzerland
(022) 713400
Circle No 536

Gespac Inc

100 W Hoover Ave
Mesa, AZ 85202
(602) 962-5559
Circle No 537

GMT Electronic Systems Ltd

Newport House
22 Hartfield Rd
Wimbledon
London SW19 3TD, UK
01-947 7234
Circle No 538

Intel Corp

5200 NE Elam Young Parkway
Hillsboro, OR 97124
(503) 640-7147
Circle No 539

Kelek Systems Ltd

80B Chapel St
Luton
Bedfordshire LU1 5DA, UK
(0582) 31803
Circle No 540

Kontron Mikrocomputer

Oskar Von Miller Str 1
8057 Eching/Munich, West Germany
(08165) 77610
Circle No 541

MLD

c/o Dean Microsystems Ltd
7 Horseshoe Park
Pangbourne
Berkshire RG8 7JW, UK
(07357) 5155
Circle No 542

Motorola Inc

Microsystem Marketing MS DW212
2900 S Diablo Way
Tempe, AZ 85282
(602) 438-3501
Circle No 543

Motorola Microsystems

Taanusstrasse 51
8000 Munich 40,
West Germany
(089) 356094
Circle No 544

PEP Elektronik Systeme GmbH

Am Klosterwald 4
8950 Kaufbeuren,
West Germany
(08341) 8974
Circle No 545

PEP Modular Computers Inc

600 N Bell Ave
Pittsburgh, PA 15106
(412) 279-6661
Circle No 546

Performance Interconnect Inc

8950 Villa La Jolla Dr
Suite 2144
La Jolla, CA 92037
(619) 457-0665
Circle No 547

Philips

Industrial Data Processing Div
Box 218
5600 MD Eindhoven,
The Netherlands
(040) 788286
Circle No 548

Plessey Microsystems Ltd

Water Lane
Towcester
Northants NN12 7JN, UK
(0327) 50312
Circle No 549

Plessey Microsystems

One Blue Hill Plaza
Pearl River, NY 10965
(914) 735-4661
Circle No 550

Quin Systems Ltd

35 Broad St
Wokingham
Berkshire RG11 1AU, UK
(0734) 783114
Circle No 551

Secad sa

Le Balmay
Vieu d'Izenave
01430 Maillat, France
(74) 757375
Circle No 552

Seidel & Ripski Elcoprint GmbH

Aidenbacher Strasse 68
8358 Vilshofen,
West Germany
(08541) 8046
Circle No 553

Siemens AG

Zentralstelle für Information
Postfach 103
8000 Munich 1,
West Germany
(089) 2340
Circle No 554

Siemens Components Inc

186 Wood Ave S
Iselin, NJ 08830
(201) 321-3400
Circle No 555

Signetics Corp

811 E Arques Ave
Sunnyvale, CA 94086
(408) 991-2000
Circle No 556

Syntel Microsystems Ltd

Queens Mill Rd
Huddersfield HD1 3PG, UK
(0484) 535101
Circle No 557

Thomson Semiconductors

Microsystems Div
Zac Des Peupliers
23 rue des Trembles
38100 Grenoble, France
(76) 493603
Circle No 558

Thomson Semiconductors

VSI
761 E University
Mesa, AZ 85203
(602) 962-9579
Circle No 559

TJP Electronics Ltd

3 West St
Scarborough
North Yorkshire YO11 2QL, UK
(0723) 360928
Circle No 560

CPU-based linking cards provide a CPU for I/O control and a subsystem interface on a single board, but they restrict you to certain processor types.

memory-extension bus, is currently being defined by an IEC working group, with the intention of making it an IEEE/IEC standard. The VSB Bus provides 32-bit data and addressing on the outer two rows of the VME Bus's P2 connector by multiplexing address and data signals onto a common set of signal lines. The bus accommodates the processing power of Motorola's 68020 μ P, and it will include interrupt facilities, allowing you to use it for I/O operations as well as for local memory extension.

Multibus II linking cards are imminent

The Multibus II specification is a collection of separate bus structures designed to support functionally partitioned computer systems. These buses include the iPSB, the local bus extension (iLBX II), the serial system bus (iSSB), the I/O expansion bus (iSBX), and the Multichannel I/O Bus. Of these, the iSBX and the Multichannel I/O Bus are capable of supporting data-acquisition and industrial-I/O functions. The iSBX is a localized bus providing a means of adding piggybacked I/O modules to single-board computers and Multibus-compatible cards, and the Multichannel I/O Bus supports high-speed I/O transfers to distributed peripherals over a ribbon cable. (Both buses conform to the electrical and mechanical specs of Multibus I. For more on Multibus I cards, see **Ref 1**).

The first half of 1986 should see the introduction of Multibus II boards that integrate Eurocard-based 8- and 16-bit buses into Multibus II systems. Slated for delivery in June is the MB2/LNK-1 coupler board from Furrer-Gloor AG. The MB2/LNK-1 links the company's range of Eurolog Bus, Z80-based 8-bit industrial-computer boards to the parallel system bus of Multibus II. The Eurolog Bus is an extension of the ECB Bus developed by Kontron Mikrocomputer GmbH, and because it maintains compatibility with the ECB Bus, the coupler board should allow you to integrate Kontron's boards into Multibus II systems.

The coupler board provides 16k to 64k bytes of dual-port RAM, through which you can pass data and interrupt messages between the iPSB and the Eurolog Bus. On the iPSB side, the board supports 8- and 16-bit data transfers, and you can set the memory address of the dual-port RAM software during system initialization. The board converts interrupt messages from the Multibus II system into Z80 vectored interrupts on the Eurolog bus, with the Multibus II interrupt source available in an interface register. The board also accepts interrupts from the Eurolog Bus and converts

them into interrupt messages that the Multibus II system can receive. You can also incorporate self tests performed by the Eurolog system into the built-in self test (BIST) capabilities of Multibus II. The MB2/LNK-1 costs approximately S Fr 2000.

Also slated for a 1986 introduction is a Siemens AG linking card that connects a Multibus II system and the company's 16-bit AMS Bus. The AMS Bus is well-suited as a subsystem bus for Multibus II systems, because it implements the Multibus I standard on double-Eurocard boards, and it uses DIN 41612 backplane connectors. This bus combination allows you to bring your Multibus I experience to Multibus II design. The entire system fits in a standard Eurocard rack. You can add a third level of processing and I/O capability to the system by linking the AMS Bus to the company's 8/16-bit SMP Bus via the P2 connector of a suitable AMS Bus CPU card or dual-port RAM card.

Firmware drivers ease software design

When choosing I/O subsystem boards, you should consider the task of integrating the boards into your system software. If you're using a manufacturer's proprietary operating system, you may well find that I/O boards from the same manufacturer come with compatible software drivers.

Consider, for example, the Versados real-time, multitasking, multiuser operating system from Motorola. The Versados operating system comes with a library of drivers for all of Motorola's VME Bus computer boards, including those that reside on a Motorola I/O Channel subsystem. When you are initially setting up your system, the Versados system-generation (SYSGEN) utility fetches the drivers appropriate to your specific board set.

Based on the RMS68K task-scheduling kernel, Versados relieves an application program of the need to interact directly with the system hardware by treating all I/O operations as if they were read and write operations to a normal file. Before your program can communicate with a particular I/O device, you assign a logical unit number, a target definition, and the type of connection required (eg, exclusive read/write) to the communication channel. A part of Versados, the input/output services (I/OS) module, effects the link between the logical unit number called by the application program and the hardware-specific software driver required for the operation.

If you can't obtain all your required I/O functions from Motorola, you can look to such board manufactur-

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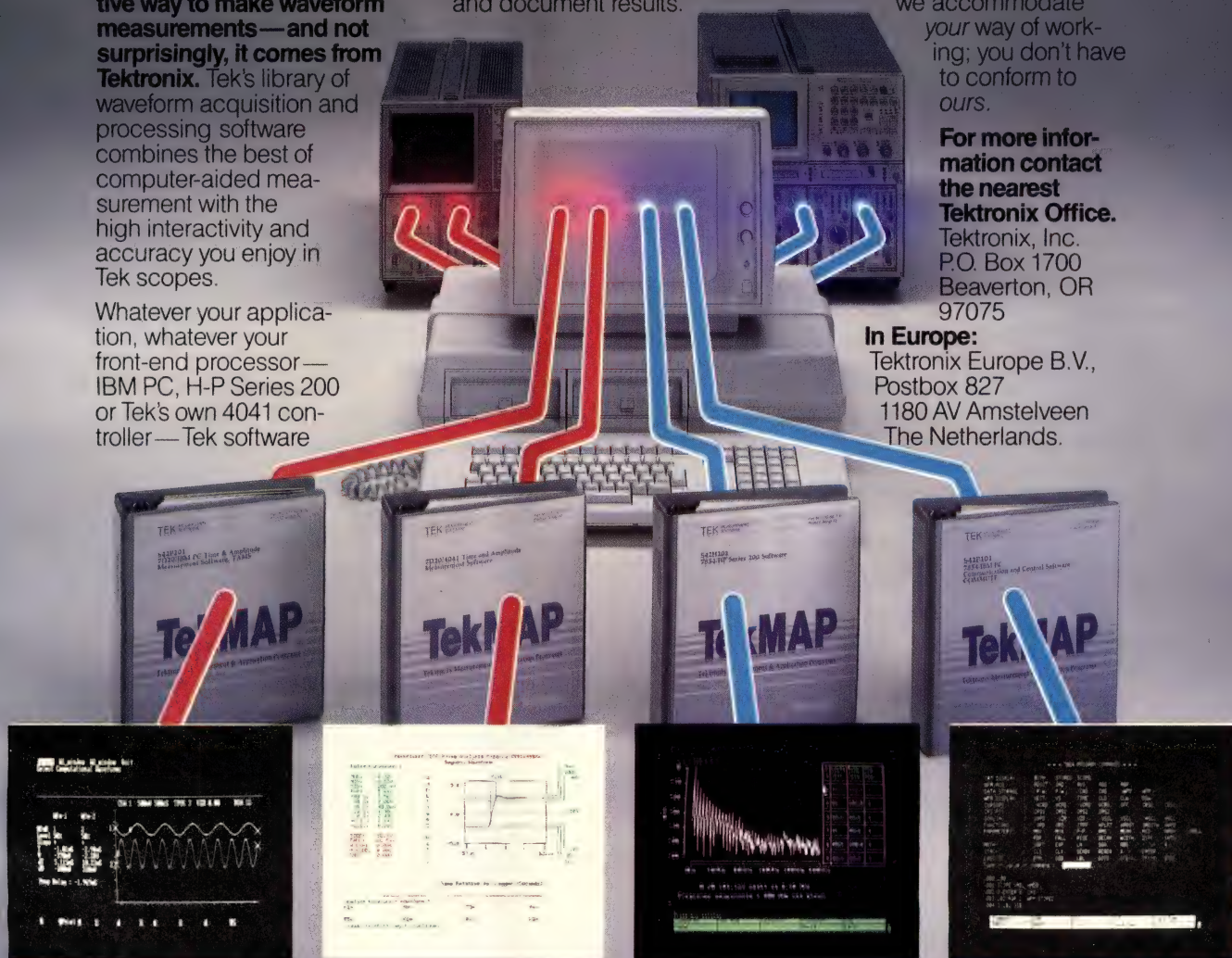
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INNOVATIVE DRIVE SYSTEMS AND FANS

ers as Plessey Microsystems and PEP Modular Computers, which supply their own device drivers for use with Versados. You can also write your own drivers, add them to your copy of the Versados driver library, and link them in by means of the SYSGEN utility.

Because Versados also supports utilities for file creation, file manipulation, software analysis, debugging, disk management, and target-system customization, it's a suitable host system for program development. Once you've written and debugged your application program, you can transfer the program, along with the RMS68K task-scheduling kernel and the device drivers, into ROMable code for your target system.

Intel's iRMX 86/Multibus II support package, when used in conjunction with the company's iRMX 86 operating system, provides a real-time, multitasking, multi-user environment for use in Multibus II systems based on the iSBC 286/100 single-board computer, or in other iAPX 286 applications. For I/O board control, device drivers link with the application program via the iRMX-86 basic I/O system (BIOS). You incorporate the drivers into the system software during system generation in much the same way you would with Versados. A device-driver library comes as part of the iRMX 86, but it only includes industrial-I/O drivers for iSBX I/O-expansion bus modules that piggyback onto suitable CPU or Multibus cards.

Device drivers for industrial I/O cards are relatively straightforward to write; the commercial availability of suitable device drivers should only be a major factor in your decision-making when you're planning to connect more complex boards—for example, disk and CRT controllers. If your industrial I/O subsystem consists simply of unintelligent slave cards located directly on the VME Bus or Multibus II backplane, or linked in an I/O-subsystem bus via a protocol-converter card, then you will have to write drivers that link with the main operating-system kernel. If, however, you incorporate CPUs on the subsystem bus or use a CPU-based linking card dedicated to I/O processing, you should be able to find a μ P/real-time-kernel combination that suits your system's price/performance goals.

EDN

Reference

1. Teja, Ed, "Intelligence, local buses preserve viability of Multibus I," *EDN*, February 6, 1986, pg 120.

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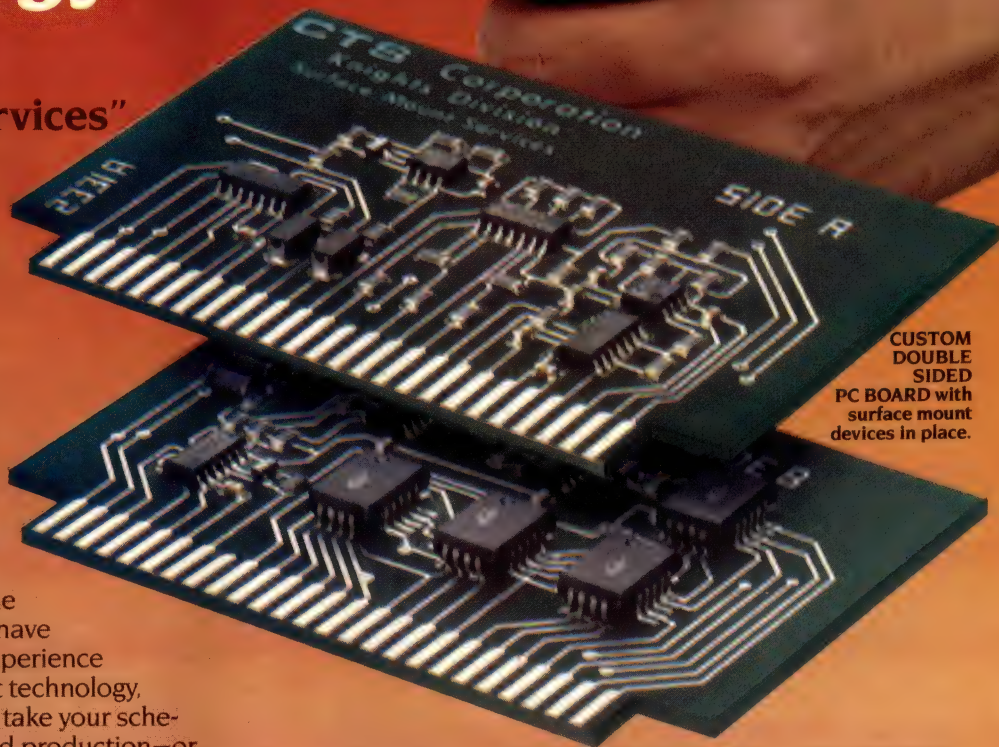
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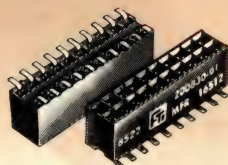
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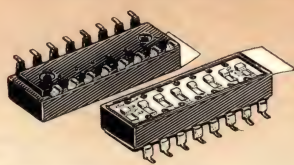
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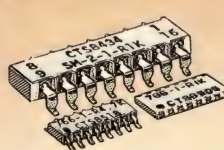
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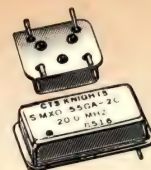
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REPRESENTATIVE DIGITAL I/O BOARDS FOR VME SUBSYSTEM BUSES

MANUFACTURER	MODEL NUMBER	EURO-CARD SIZE	NUMBER OF CHANNELS				INPUT
			INPUT	OUTPUT	INPUT/OUTPUT	HAND-SHAKE	DC VOLTAGE**
DIGITAL I/O BOARDS FOR THE G64 BUS							
DEVLOINCS CONTROL	DPIC	S	20				2 TO 48V
	DVPSA	S			64	16	TTL
	DPOC	S		16			
GESPAC	GESINP-1	S	32				12, 24V, (48V OPT)
	GESCIO-1A	S	16	16			12 TO 24V
	GESCIO-1B	S	16	16			12 TO 24V
	GESCNX-1B	S	19	20			TTL
	GESPIA-2A	S			32	8	TTL
	GESPIA-3A	S			32	8	TTL
	GESOUT-2A	S		32			
	GESOUT-2B	S		32			
SYNTEL MICROSYSTEMS	IPM1	S	16				24V
	TIO1	S			32	8	TTL
	OPM1	S		8			
TJP ELECTRONICS	TJP-G64-INO1	S	12	4			40 mA MAX
	TJP-G64-OUT1	S	4	12			40 mA MAX
DIGITAL I/O BOARDS FOR THE II/OC/EUROBUS							
PEP MODULAR COMPUTERS	PI	S	38				12, 24, 36, 48, 60V
	PIO-4	S	2	2	16		20 mA MAX
	IIO	S	16			4	24, 48, 60 DC, AC OR 110V AC
					16	4	TTL
	CIM-2/-3	S			40		TTL
	PIM-2A	S			40		TTL
	RLM-1	S		8			
DORSCH MIKROSYSTEM	DIGIN-24	S	16				24V
	PIA-MODUL	S			32	8	TTL
	DIGOUT-24	S		16			
EKF-ELEKTRONIK	10221-PIA2	S			32	8	TTL
	10222-VIA2	S			32	8	TTL
	10231-POR	S			16	4	1 mA INTO OPTO-COUPLER DIODE
	10235-POT	S			16	4	OPTOCOUPLED
	10241-PEX	S			16	4	TTL
DIGITAL I/O BOARDS FOR THE MOTOROLA I/O CHANNEL							
MOTOROLA	MVME620	S	8				10 TO 70V
	MVME610	S	8				90 TO 264V AC
	MVME410	S			32	8	TTL
	MVME625	S		8			
	MVME615/616	S		8			
DIGITAL I/O BOARDS FOR THE STE BUS							
ARCOM CONTROL SYSTEMS	SPIBB	S			32		TTL
					8		TTL
DATABETA	DBS-16I	D	16				250V AC, DC
	DBS-16O	D		16			
DSP DESIGNS	SPL440	S			40		TTL
GMT ELECTRONIC SYSTEMS	3755-1	D	16				110V DC, AC
	1030-1	S			32	8	TTL
	3755-2	D		16			
	3755-3	D		16			
KELEK SYSTEMS	KSL-S016			16			
					8		TTL
MLD	MLD-PIT-1	S			16	4	TTL
PERFORMANCE INTERCONNECT	SIO3	S			32	8	TTL

KEY:

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D DOUBLE HEIGHT S SINGLE HEIGHT
HNIL HIGH-NOISE-IMMUNITY LOGIC TTL TTL-COMPATIBLE INPUT OR OUTPUT
OPT OPTIONAL

OUTPUT		ISOLATION		PRICE	COMMENTS
DC VOLTAGE	CURRENT	TYPE	VOLTAGE		
		OPTO	—	B fr 13,500	OPTIONAL 16-BIT COUNTER/TIMER
TTL	—			B fr 15,600	TWO SERIAL PORTS; OPTIONAL FOUR 16-BIT COUNTER/TIMERS
5, 12, 24, 48V	2A	OPTO	—	B fr 16,000	OPTIONAL 16-BIT COUNTER/TIMER
		OPTO	1.5 kV	S fr 600	FIVE DEBOUNCED INTERRUPT INPUTS
12 TO 24V	100 mA	OPTO	1.5 kV	S fr 800	SIX DEBOUNCED INPUTS
12 TO 24V	100 mA	OPTO	1.5 kV	S fr 800	SIX DEBOUNCED INPUTS
TTL	24 mA			S fr 350	ONE PORT CONFIGURED AS A CENTRONICS-COMPATIBLE INTERFACE
TTL	2 TTL			S fr 300	OPTIONAL PROTOTYPING VERSION
TTL	1 TTL			S fr 400	FOUR 16-BIT TIMERS; OPTIONAL PROTOTYPING VERSION
12, 24, 48V	100 mA	OPTO	1.5 kV	S fr 600	
	100 mA	OPTO	1.5 kV	S fr 600	
		OPTO	—	£169	TWO TIMERS; SHIFT REGISTER AND COUNTER
5 TO 50V	300 mA			£163	THREE 16-BIT COUNTER/TIMERS
24V	2A	OPTO	—	£194	COUNTER/TIMER; SHIFT REGISTER
24V	—	OPTO	—	£193	16-BIT TIMER; SHIFT REGISTER
24V	—	OPTO	—	£193	16-BIT TIMER; SHIFT REGISTER
		OPTO	—	DM 670	SIX DEBOUNCED INPUTS; OPTIONAL LED STATUS DISPLAY
28V	2A	OPTO	—	DM 580	OPTIONAL SHORT-CIRCUIT OUTPUT PROTECTION; OPTIONAL 60-mA OUTPUT CURRENT
		OPTO	—	DM 720	OPTIONAL LED STATUS DISPLAY
TTL	—				
TTL	—			DM 450	THREE 16-BIT TIMERS; OPTIONAL TWO SERIAL PORTS
TTL	—			DM 323	
380V	8A	RELAY	—	DM 340	SPDT RELAYS
		OPTO	—	DM 610	LED STATUS DISPLAY
TTL	—			DM 390	
24V	150 mA	OPTO	—	DM 860	LED STATUS DISPLAY
TTL	—			DM 290	
TTL	—			DM 370	COUNTER/TIMER; SHIFT REGISTER; PROTOTYPING AREA
100V	500 mA	RELAY	—	DM 550	CONFIGURABLE FOR OPTOCOUPLED INPUTS, 100V/0.5A RELAY OUTPUTS, OR NONISOLATED OPEN-COLLECTOR 30V/40-mA OUTPUTS
30V	500 mA	OPTO	—	DM 550	
TTL	—			DM 280	PROTOTYPING AREA
		OPTO	2.5 kV	\$325	
		OPTO	2.5 kV	\$350	
TTL	—			\$350	CENTRONICS-COMPATIBLE CONNECTORS
10 TO 60V	2A	OPTO	2.5 kV	\$340	
120 TO 260V AC	2A	OPTO	2.5 kV	\$350	MVME615 HAS ZERO-CROSSOVER SWITCHING
TTL	24 mA SINK 15 mA SOURCE			£123.50	STANDARD I/O BUS FOR RIBBON-CABLE CONNECTION TO A RANGE OF SINGLE-EUROCARD SIGNAL-CONDITIONING BOARDS
TTL	—				
		OPTO	2 kV	£130	
250V AC	500 mA	RELAY	1 kV RMS	£130	
TTL	—			£250	FOUR SERIAL PORTS; SIX 16-BIT COUNTER/TIMERS
				£210	
TTL	—			£155	TWO BUFFERED PIA INTERFACES
110V	1A	RELAY	—	£210	
110V AC	1A	OPTO	—	£357	SOLID-STATE ZERO-CROSSOVER SWITCHES
50V	2A	OPTO	—	£245	
TTL	—				
TTL	—			£150	24-BIT COUNTER/TIMER; PROTOTYPING AREA
TTL	24 mA SINK 15 mA SOURCE			\$275	TWO 24-BIT COUNTER/TIMERS

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Table continued on pg 188

REPRESENTATIVE DIGITAL I/O BOARDS FOR VME SUBSYSTEM BUSES (Continued)

MANUFACTURER	MODEL NUMBER	EURO- CARD SIZE	NUMBER OF CHANNELS			INPUT	
			INPUT	OUTPUT	INPUT/ OUTPUT	HAND- SHAKE	DC VOLTAGE**
DIGITAL I/O BOARDS FOR THE MIOS BUS							
PHILIPS	PC1711	D	32				5 TO 48V
	PC1710	D	32				-40 TO +50V
	PC1716	D	16	16		4	5 TO 48V
	PC1721	D		32			
	PC1722	D		16			
	PC1715	D	16	16			-40 TO +50V
	PC1720	D		32			
DIGITAL I/O BOARDS FOR THE BSB BUS							
PHILIPS	PC2310	S	32				15V TTL INPUT; 29V HNIL INPUT
	PC2311	S	16				5, 12, 24, 48V
	PC2316	S	8	8			5V+5%, 12V+10%, 24V+20%, 48V+20%
	PC2320	S		32			
	PC2321	S		16			
	PC2323	S		8			
	PC2324	S		32			

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OPT OPTIONAL

REPRESENTATIVE DIGITAL I/O BOARDS FOR MULTIBUS II SUBSYSTEM BUSES

MANUFACTURER	MODEL NUMBER	EURO-CARD SIZE	NUMBER OF CHANNELS				INPUT
			INPUT	OUTPUT	INPUT/OUTPUT	HAND-SHAKE	DC VOLTAGE**
DIGITAL I/O BOARDS FOR THE AMS-M BUS							
SEIDEL & RIPSKE ELCOPRINT	OPTOIN16-2	S	16				30V
	OPTOIN32-1	S	32				30V
	PPI48-1	S			48		TTL
	PPI48-2	S			48		TTL
	OPTOUT16-1/-2	S		16			
	OPTOUT24-1	S		24			
	REL8-1	S		8			
	REL8-2	S		8			
	ISBX-1	S					
SIEMENS	AMS-M212	D	64				5, 12, 24V
	AMS-M203	D	32	16 OPT			24V
	AMS-M261	D		32			
DIGITAL I/O BOARDS FOR THE SMP BUS							
SIEMENS	AMS-M212	D	64				5, 12, 24V
	AMS-M203	D	32	16 OPT			24V
	AMS-M261	D		32			
DIGITAL I/O BOARDS FOR THE EUROLOG BUS							
FURRER-GLOOR	EML-DIC16	S	16				12, 24, 48V
	EML-DIC88	S	8	8			12, 24, 48V
	EML-PIC1	S			32		TTL
	EML-PIC2	S			48		TTL
	EML-PIC3	S			36		TTL
					12		TTL
	EML-DOC32	S		32			

KEY:

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D DOUBLE HEIGHT S SINGLE HEIGHT
OPT OPTIONAL TTL TTL-COMPATIBLE INPUT OR OUTPUT

OUTPUT		ISOLATION		PRICE	COMMENTS
DC VOLTAGE	CURRENT	TYPE	VOLTAGE		
		OPTO	250V	GLD 1810	TTL/HNIL- AND GROUNDED-LOAD-COMPATIBLE VERSIONS
				GLD 785	TTL/HNIL-COMPATIBLE INPUTS
24V	250 mA	OPTO	250V	GLD 2390	TTL/HNIL- AND GROUNDED-LOAD-COMPATIBLE VERSIONS
24V	250 mA	OPTO	250V	GLD 1600	TTL/HNIL- AND GROUNDED-LOAD-COMPATIBLE VERSIONS
80V	450 mA	OPTO	250V	GLD 1050	SHORT-CIRCUIT-PROTECTED OUTPUTS
30V	37 mA			GLD 1715	TTL/HNIL-COMPATIBLE INPUTS AND OUTPUTS
30V	37 mA			GLD 662	TTL/HNIL-COMPATIBLE OUTPUTS
				GLD 593	
		OPTO	250V	GLD 522	
60V	200 mA	OPTO	250V	GLD 718	
30V	40 mA			GLD 420	
60V	200 mA	OPTO	250V	GLD 533	
60V	2A	OPTO	—	GLD 718	
60V	200 mA			GLD 765	

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OUTPUT		ISOLATION		PRICE	COMMENTS
DC VOLTAGE	CURRENT	TYPE	VOLTAGE		
		OPTO	5 kV	DM 450	LED STATUS DISPLAY
		OPTO	5 kV	DM 530	
TTL	—			DM 670	OPEN-COLLECTOR, TOTEM-POLE, OR 3-STATE OUTPUTS
TTL	—			DM 670	OPEN-COLLECTOR, TOTEM-POLE, OR 3-STATE OUTPUTS
30V	1A	OPTO	4.4 kV	DM 630	—1 VERSION IS CURRENT SOURCE, —2 VERSION IS CURRENT SINK
45V	500 mA	OPTO	5 kV	DM 490	
100V	2A	RELAY	—	DM 580	
220V	3A	RELAY	—	DM 390	
				DM 440	ACCEPTS TWO iSBX MODULES; OPTIONAL DMA CAPABILITY
		OPTO	500V	DM 2250	SMP BUS INTERFACE; LED STATUS DISPLAY
24V	1A	OPTO	500V	DM 1630	SMP BUS INTERFACE; LED STATUS DISPLAY; OPTIONAL OUTPUTS REQUIRE TWO AMS-S260 PLUG-IN MODULES
24V	100 mA	OPTO	500V	DM 1580	SMP BUS INTERFACE; LED STATUS DISPLAY
		OPTO	500V	DM 2250	AMS-M BUS INTERFACE; LED STATUS DISPLAY
24V	1A	OPTO	500V	DM 1630	AMS-M BUS INTERFACE; LED STATUS DISPLAY; OPTIONAL OUTPUTS REQUIRE TWO AMS-S260 PLUG-IN MODULES
24V	100 mA	OPTO	500V	DM 1580	AMS-M BUS INTERFACE; LED STATUS DISPLAY
		OPTO	—	S fr 532	LED STATUS DISPLAY
60V	800 mA	OPTO	—	S fr 532	LED STATUS DISPLAY
60V	1A AC, DC	RELAY	—		
TTL	—			S fr 390	32 ONBOARD DIL SWITCHES FOR DATA ENTRY
TTL	—			S fr 461	FOUR COUNTER/TIMER CHANNELS; REAL-TIME CLOCK; PROTOTYPING AREA
TTL	—			S fr 604	SYSTEM WATCHDOG; REAL-TIME CLOCK/CALENDAR
24V	300 mA				
60V	800 mA	OPTO	—	S fr 590	

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REPRESENTATIVE ANALOG I/O BOARDS FOR VME SUBSYSTEM BUSES

MANUFACTURER	MODEL NUMBER	EURO-CARD SIZE	ANALOG INPUTS						
			CHANNELS (SE/DIF)	BEST RESOLUTION (BITS)	BEST ACCURACY (% FSR)	LINEARITY (LSB)	INPUT RANGES (V)**	RANGING	CONVERSION TIME* (μSEC)**
ANALOG I/O BOARDS FOR THE G64 BUS									
GESPAC	GESADC-2	S	16/8	12	0.024	—	5, ±5, RPGA (×2 TO ×500)	LP	30
	GESADC-2A	S	16/8	12	0.024	—	5, ±5, SPGA (×1 TO ×1024 IN 11 BINARY STEPS)	LP/SP	30
	GESADC-2B	S	16/8	12	0.024	—	10, ±5, ±10, RPGA (×1 TO ×1000)	LP	30
	GESADC-2C	S	16/8	12	0.024	—	10, ±5, ±10, SPGA (×1 TO ×1024 IN 11 BINARY STEPS)	LP/SP	30
	GESADA-1	S	16/8	12	0.1	—	10, ±5, ±10	LP	35
	GESADA-1A	S	16/8	12	0.1	—	10, ±5, ±10, RPGA (×1 TO ×1000)	LP	35
	GESDAC-1	S							
	GESDAC-2A	S							
SYNTEL MICROSYSTEMS	SYN-ADC3	S	8 SE	12	—	0.5	10, ±5, ±10	LP	30
	SYN-ADC4	S	32 SE	12	—	0.5	10, ±5, ±10	LP	30
	SYN-ADC4-A	S	32/16	12	—	0.5	10, ±5, ±10, RPGA (×1 TO ×1000)	LP	30
	SYN-ADC2	S	8 SE	12	—	0.5	10, ±5, ±10	LP	30
	SYN-DAC4	S							
	SYN-DAC8	S							
TJP ELECTRONICS	TJP-G64-ADC01	S	14	12	—	1	10, 20, ±5, ±10	LP	25
	TJP-G64-ADC02	S	14	12	—	1	10, 20, ±5, ±10, RPGA (×1, ×4, ×10), SPGA (×1, ×2, ×5, ×10)	LP/SP	25
	TJP-G64-AN01	S							
ANALOG I/O BOARDS FOR THE II/OC/EUROBUS									
PEP MODULAR COMPUTERS	ADI-1A	S	16/8	12	—	0.5	5, 10, ±5, ±10, SPGA (×1, ×10, ×100, ×1000)	SP	35
	DAM-159-1	S	15	8	0.39	0.5	9 INPUTS ±10V, 6 INPUTS 5V		32
	DAM-159-0	S	15	8	0.39	0.5	9 INPUTS ±10V, 6 INPUTS 5V		32
	DAM-159-2	S							
	DAI-1A	S							
DORSCH MICROSYSTEM	AI-12	S	16/8	12	0.024	—	10, ±5, ±10	LP	30
	AIO-12	S	16/8	12	0.024	—	10, ±5, ±10	LP	30
	AO-12	S							
EKF-ELECTRONIK	10932-ADC12	S	16/8	12	—	0.5	10, ±5, ±10, SPGA (×1, ×2, ×4, ×8)	LP/SP	20
	10953-DAC12	S							

KEY:

— INFORMATION NOT PROVIDED	OPT OPTIONAL
D DOUBLE HEIGHT	RPGA RESISTOR-PROGRAMMABLE GAIN AMPLIFIER
DIF DIFFERENTIAL	S SINGLE HEIGHT
FSR FULL-SCALE RANGE	SE ENDED
HNIL HIGH-NOISE-IMMUNITY LOGIC	SP SOFTWARE PROGRAMMABLE
LP LINK PROGRAMMABLE	SPGA SOFTWARE-PROGRAMMABLE GAIN AMPLIFIER
LSB LEAST SIGNIFICANT BIT	TYP TYPICAL
OPT OPTIONAL	

A BLANK ENTRY INDICATES THAT THE FUNCTION IS NOT OFFERED.

MAXIMUM THROUGHPUT* (kHz)	ANALOG OUTPUTS						PRICE	COMMENTS
	CHANNELS	RESOLUTION (BITS)	BEST ACCURACY (% FSR)	LINEARITY (LSB)	OUTPUT RANGES (V)**	SETTLING TIME (μSEC)**		
—							S fr 1600	8- OR 16-BIT G64 BUS TRANSFERS; 5V-ONLY OPERATION
—							S fr 2000	8- OR 16-BIT G64 BUS TRANSFERS; 5V-ONLY OPERATION
—							S fr 1850	8- OR 16-BIT G64 BUS TRANSFERS; 5V-ONLY OPERATION
—							S fr 2250	8- OR 16-BIT G64 BUS TRANSFERS; 5V-ONLY OPERATION
25	4	12	0.1	—	10, ±5, ±10	4	S fr 1500	REQUIRES EXTERNAL ±12 OR ±15V SUPPLY FOR ±10V OPERATION
25	4	12	0.1	—	10, ±5, ±10	4	S fr 1600	REQUIRES EXTERNAL ±12 OR ±15V SUPPLY FOR ±10V OPERATION
	4	12	0.057	0.5	5, 10, ±2.5, ±5, ±10	3 TYP	S fr 1250	
	8	12	0.042	1	10, ±5, ±10	3 TO 0.01% FSR	S fr 1800	
—							£339	TWO TTL-LEVEL DIGITAL OUTPUTS
—							£475	OPTIONAL ONBOARD, 5 TO ±15V DC/DC CONVERTER (SYN-ADC4-B)
—							£525	OPTIONAL ONBOARD, 5 TO ±15V DC/DC CONVERTER (SYN-ADC4-C)
—	2	12	—	0.5	10, ±10	—	£439	TWO TTL-LEVEL DIGITAL OUTPUTS
	4	12	—	1	10, ±10	—	£395	ADJUSTABLE 10V REFERENCE; EXTERNAL REFERENCE INPUT
	8	12	—	1	10, ±10	—	£595	ADJUSTABLE 10V REFERENCE; EXTERNAL REFERENCE INPUT
—							£264	SEPARATE 0 AND 2.5V REFERENCE INPUTS ON INPUT MULTIPLEXER
—							£425	SEPARATE 0 AND 2.5V REFERENCE INPUTS ON INPUT MULTIPLEXER
	4	12	—	0.5	5, 10, ±2.5, ±5, ±10	4 TO 0.01% FSR	£257	RELAY-SWITCHED OUTPUT CHANNELS; FOUR OPTOISOLATED DIGITAL INPUTS
—							DM 1450	5V-ONLY OPERATION; SOFTWARE ZERO ADJUSTMENT
—							DM 705	SIX DIGITAL I/O LINES; DC/DC CONVERTER OPTION FOR 5V-ONLY OPERATION
—	8	8	—	—	10	—	DM 1310	SIX DIGITAL I/O LINES; DC/DC CONVERTER OPTION FOR 5V-ONLY OPERATION
	8	8	—	—	10	—	DM 860	SIX DIGITAL I/O LINES; DC/DC CONVERTER OPTION FOR 5V-ONLY OPERATION
	4	12	—	—	5, 10, ±2.5, ±5, ±10	—	DM 1250	5V-ONLY OPERATION
30							DM 1850	
30	6	12	—	—	10, ±5, ±10	10	DM 2890	OPTIONAL 4-OUTPUT VERSION
	6	12	—		10, ±5, ±10	10	DM 1180	OPTIONAL 4-OUTPUT VERSION
—							DM 1440	5V-ONLY OPERATION
	4	12	—	0.5	10, ±5, ±10	3	DM 930	5V-ONLY OPERATION

*CONVERSION TIME AND THROUGHPUT FIGURES MAY NOT INCLUDE CHANNEL ACQUISITION, AMPLIFIER SETTLING, OR SAMPLE/HOLD SETTLING TIMES. THESE FIGURES SHOULD THEREFORE ONLY BE USED AS A GUIDE WHEN COMPARING DIFFERENT BOARDS. IN ADDITION, THE FIGURES MAY BE WORSE FOR SOME INPUT RANGES.

**UNLESS OTHERWISE SPECIFIED.

Table continued on pg 192

REPRESENTATIVE ANALOG I/O BOARDS FOR VME SUBSYSTEM BUSES (Continued)

MANUFACTURER	MODEL NUMBER	EURO-CARD SIZE	ANALOG INPUTS						
			CHANNELS (SE/DIF)	BEST RESOLUTION (BITS)	BEST ACCURACY (% FSR)	LINEARITY (LSB)	INPUT RANGES (V)**	RANGING	CONVERSION TIME* (μSEC)**
ANALOG I/O BOARDS FOR THE MOTOROLA I/O-CHANNEL									
MOTOROLA	MVME600	S	16/8	12	0.1	0.5	±5, ±10, SPGA (×1, ×10), 4 TO 20 mA, 10 TO 50 mA	LP/SP	38
	MVME605	S							
ANALOG I/O BOARDS FOR THE STE BUS									
ARCOM CONTROL SYSTEMS	ADC12/16	S	16 DIF	12 + SIGN	—	0.5	±4.096		30 mSEC MAX
	ADC12/16H	S	16 DIF	12	—	1	±5, SPGA (×1, ×10, ×100)	SP	25
	ADA8/16-2	S	16/8	8	—	0.5	5.1, ±5	LP	9
GMT ELECTRONIC SYSTEMS	1032-1	S	32/16	12	0.024	1	10, ±5, ±10, RPGA (×1 TO ×1000)	LP	50 TYP
	1032-2	S	32/16	12	0.024	1	10, ±5, ±10	LP	50 TYP
	1032-3	S	16/8	12	0.024	1	10, ±5, ±10, RPGA (×1 TO ×1000)	LP	50 TYP
	1032-4	S	16/8	12	0.024	1	10, ±5, ±10	LP	50 TYP
	1031-1	S							
KELEK SYSTEMS	AD44S-A	S	8/4	12	—	1, OPT 0.5	±0.1, ±0.5, ±1, ±5	SP	25
	AD44	S	8/4	12	—	—	±0.1, ±0.5, ±1, ±5	SP	200 mSEC
	AD44S	S	8/4	12	—	1, OPT 0.5	±0.1, ±0.5, ±1, ±5	SP	25
	AD44S-D	S							
ANALOG I/O BOARDS FOR THE MIOS BUS									
PHILIPS	PC1750/00	D	1 DIF	12	—	—	0.02, 0.05, 0.1, 0.2, 0.5, 1, 2, 10	—	25
	PC1755/00	D	32/16	12	—	—	5, 10, ±2.5, ±5, ±10	—	25
	PC1751/00	D							
	PC1761/00	D							
ANALOG I/O BOARDS FOR THE BSB BUS									
PHILIPS	PC2350	S	1 DIF	10	0.25	—	1.024		—
	PC2361	S							

KEY:

— INFORMATION NOT PROVIDED OPT OPTIONAL
D DOUBLE HEIGHT RPGA RESISTOR-PROGRAMMABLE GAIN AMPLIFIER
DIF DIFFERENTIAL S SINGLE HEIGHT
FSR FULL-SCALE RANGE SE SINGLE ENDED
HNIL HIGH-NOISE-IMMUNITY LOGIC SP SOFTWARE PROGRAMMABLE
LP LINK PROGRAMMABLE SPGA SOFTWARE-PROGRAMMABLE GAIN AMPLIFIER
LSB LEAST SIGNIFICANT BIT TYP TYPICAL
OPT OPTIONAL

A BLANK ENTRY INDICATES THAT THE FUNCTION IS NOT OFFERED.

MAXIMUM THROUGHPUT* (kHz)	CHANNELS	ANALOG OUTPUTS					PRICE	COMMENTS
		RESOLUTION (BITS)	BEST ACCURACY (% FSR)	LINEARITY (LSB)	OUTPUT RANGES (V)**	SETTLING TIME (μSEC)**		
—							\$750	EXPANDABLE TO 96 CHANNELS WITH MVME601 MUX CARDS; 5V-ONLY OPERATION
	4	12	0.125	—	±2.5, ±5, ±10, 4 TO 20 mA	1.5	\$675	SIMULTANEOUS CURRENT- AND VOLTAGE-MODE OUTPUTS
—							£185.50	STANDARD ANALOG BUS ACCEPTS RANGE OF SIGNAL-CONDITIONING MODULES
—							~£350	STANDARD ANALOG BUS ACCEPTS RANGE OF SIGNAL-CONDITIONING MODULES
—	2	8	—	0.5	5, 10	2	£185.50	STANDARD ANALOG BUS ACCEPTS RANGE OF SIGNAL-CONDITIONING MODULES
18							£358	5V-ONLY OPERATION
18							£335	5V-ONLY OPERATION
18							£318	5V-ONLY OPERATION
18							£295	5V-ONLY OPERATION
	2	12	0.024	1	5, 10, ±2.5, ±5, ±10	3 TO 0.01%	£189	5V-ONLY OPERATION
20							£258	CONFIGURABLE FOR ±10V INPUT
—	4	12	—	1, OPT 0.5	±5	5	~£400	CONFIGURABLE FOR ±10V INPUT/OUTPUT
20	4	12	—	1, OPT 0.5	±5	5	£440	CONFIGURABLE FOR ±10V INPUT/OUTPUT
	4	12	—	1, OPT 0.5	±5	5	£278	CONFIGURABLE FOR ±10V OUTPUT
—							GLD 4990	100 CHANNEL/SEC WITH RELAY MUX BOARDS; A/D ISOLATION
25							GLD 2720	
	8	SEE COMMENTS	0.02		0, 18, 45, 90, 180, 450, 900, 180 mV		GLD 3240	FIXED SELECTABLE MILLIVOLT REFERENCE OUTPUTS
	2	12	—	—	10, 0 TO 20 mA, 4 TO 20 mA	3	GLD 2390	TTL/HN1L-COMPATIBLE PEN-LIFT DIGITAL OUTPUT
—							GLD 3120	SEPARATE MUX BOARDS FOR 100-CHANNEL/SEC SAMPLING; A/D ISOLATION
	2	8	0.5	—	0 TO 20 mA	10 mSEC	GLD 1060	D/A ISOLATION

*CONVERSION TIME AND THROUGHPUT FIGURES MAY NOT INCLUDE CHANNEL ACQUISITION, AMPLIFIER SETTLING, OR SAMPLE/HOLD SETTLING TIMES. THESE FIGURES SHOULD THEREFORE ONLY BE USED AS A GUIDE WHEN COMPARING DIFFERENT BOARDS. IN ADDITION, THE FIGURES MAY BE WORSE FOR SOME INPUT RANGES.

**UNLESS OTHERWISE SPECIFIED.

REPRESENTATIVE ANALOG I/O BOARDS FOR MULTIBUS II SUBSYSTEM BUSES

MANUFACTURER	MODEL NUMBER	EURO-CARD SIZE	ANALOG INPUTS						
			CHANNELS (SE/DIF)	BEST RESOLUTION (BITS)	BEST ACCURACY (% FSR)	LINEARITY (LSB)	INPUT RANGES (V)**	RANGING	CONVERSION TIME* (μSEC)**
ANALOG I/O BOARDS FOR THE AMS-M BUS									
SIEDEL & RIPSKE ELCOPRINT	ADC12-1	S	16/8	12	—	1	10, 20, ±5, ±10, RPGA (×1, ×10, ×100, ×1000)	LP	25
	DAC80-1	S							
SIEMENS	AMS-M230	D	32/16	12	—	—	EIGHT INPUT RANGES, SPGA	LP/SP	—
ANALOG I/O BOARDS FOR THE EUROLOG BUS									
FURRER-GLOOR	EML/AIC-16	S	16/8	12	—	1	±0.05, ±0.1, ±0.5, ±1, ±2.5, ±5	LP	42
	EML/AIO-82	S	8	8	—	—	5, 10, ±5, ±10, 0 TO 20 mA, 4 TO 20 mA	LP	4.4
	EML/AOC-4	S							

KEY:

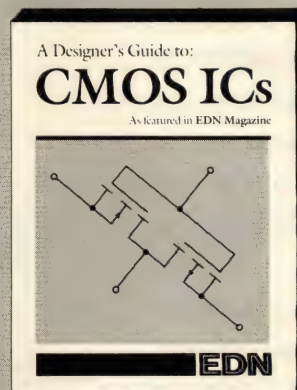
—	INFORMATION NOT PROVIDED	RPGA	RESISTOR-PROGRAMMABLE GAIN AMPLIFIER
D	DOUBLE HEIGHT	S	SINGLE HEIGHT
DIF	DIFFERENTIAL	SE	SINGLE ENDED
LP	LINK PROGRAMMABLE	SP	SOFTWARE PROGRAMMABLE
LSB	LEAST SIGNIFICANT BIT	SPGA	SOFTWARE-PROGRAMMABLE GAIN AMPLIFIER
OPT	OPTIONAL	TYP	TYPICAL

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MAXIMUM THROUGHPUT* (kHz)	CHANNELS	ANALOG OUTPUTS					PRICE	COMMENTS
		RESOLUTION (BITS)	BEST ACCURACY (% FSR)	LINEARITY (LSB)	OUTPUT RANGES (V)**	SETTLING TIME (μSEC)**		
—							DM 1450	OPTIONAL A/D ISOLATION; 30-mA CURRENT SOURCE FOR BRIDGE ENERGIZATION
	4	12	—	0.5	5, 10, ±2.5, ±5, ±10, 0 TO 16 mA, 4 TO 20 mA	3	DM 1350	OPTIONAL D/A ISOLATION
37							DM 4365	
—							S fr 1215	15 TTL-LEVEL DIGITAL I/O LINES; EXTERNAL REFERENCE INPUT; 5V-ONLY OPERATION; OPTIONALLY UNPOPULATED WITH CONVERTER MODULE
—	2	8	—		2.5, 0 TO 20 mA, 4 TO 20 mA	—	S fr 1002	5V-ONLY OPERATION
	4	12	0.012		5, 10, ±2.5, ±5, ±10, 0 TO 2 mA, ±1 mA	5	S fr 1019	5V-ONLY OPERATION

*CONVERSION TIME AND THROUGHPUT FIGURES MAY NOT INCLUDE CHANNEL ACQUISITION, AMPLIFIER SETTLING, OR SAMPLE/HOLD SETTLING TIMES. THESE FIGURES SHOULD THEREFORE ONLY BE USED AS A GUIDE WHEN COMPARING DIFFERENT BOARDS. IN ADDITION, THE FIGURES MAY BE WORSE FOR SOME INPUT RANGES.

**UNLESS OTHERWISE SPECIFIED.

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REPRESENTATIVE SPECIALIZED I/O BOARDS FOR VME SUBSYSTEM BUSES

MANUFACTURER	MODEL NUMBER	EURO-CARD SIZE	DESCRIPTION	PRICE	COMMENTS
SPECIALIZED I/O BOARDS FOR THE G64 BUS					
CONTROL VISION INDUSTRIES	CVI.CMP-G1	S	DUAL-STEPPER-MOTOR CONTROLLER	Fr fr 4765	ONBOARD 68705 μ P AND MOTOR-CONTROL FIRMWARE; 12V/500-mA PER WINDING DRIVE CAPABILITY; DIGITAL I/O
	CVI.ICLA-G1	S	ANALOG-OUTPUT CCD LINE-SCAN CAMERA INTERFACE	Fr fr 5365	ANALOG INPUT; 6-BIT GRAY-SCALE DIGITAL OUTPUT; EXPOSURE CONTROL
	CVI.ICLN-G1	S	DIGITAL-OUTPUT CCD LINE-SCAN CAMERA INTERFACE	Fr fr 9495	ONBOARD 68705 μ P FOR CONTROL OF TWO CAMERAS
GESPAC	GESBRG-1	S	RESISTOR-BRIDGE INTERFACE	S fr 1500	400-Hz AC BRIDGE CONDITIONING; PROGRAMMABLE BRIDGE SENSITIVITY; 12-BIT RESOLUTION PLUS SIGN; 80-mSEC CONVERSION TIME
	GESDMC-1	S	DC-SERVO-MOTOR CONTROLLER	S fr 2500	ONBOARD 6809 μ P AND MOTOR-CONTROL FIRMWARE; SHAFT-ENCODER INPUT; 16-BIT D/A OUTPUT
	GESINC-1	S	INCREMENTAL-OPTICAL-ENCODER INTERFACE	S fr 900	OPTICALLY COUPLED INPUTS; 24-BIT COUNTER AND COMPARATOR; 500-kHz MAX PULSE FREQUENCY; ABSOLUTE AND RELATIVE MODES OF OPERATION
	GESRTD-1	S	RESISTANCE-TEMPERATURE-DETECTOR INTERFACE	S fr 2000	FOUR PT100-COMPATIBLE INPUT CHANNELS; -250 TO +750°C RANGE; 12-BIT A/D CONVERTER; 3000-CHANNEL/SEC SCANNING
	GESMC-1	S	DUAL-STEPPER-MOTOR CONTROLLER	S fr 2500	ONBOARD 6809 μ P AND MOTOR-CONTROL FIRMWARE; FOUR OPTO-ISOLATED DIGITAL OUTPUTS AND ONE INPUT PER MOTOR
	GESTCD-1	S	THERMOCOUPLE TEMPERATURE-MEASUREMENT MODULE	S fr 2500	
QUIN SYSTEMS	PLC-1	S	PROGRAMMABLE-LOGIC CONTROLLER	£295	ONBOARD 6805 μ P; PROTOTYPING AREA; 21 TTL-LEVEL DIGITAL LINES; SERIAL PORT; PLC LADDER LOGIC OS-9-COMPATIBLE FIRMWARE
	DSC-1	S	SINGLE-AXIS, CLOSED-LOOP DC MOTOR CONTROLLER	~ £650	ONBOARD 6809 μ P; 12-BIT D/A MOTOR-CONTROL OUTPUT; SHAFT-ENCODER INPUT; ONBOARD, OS-9-COMPATIBLE MOTOR-CONTROL FIRMWARE
TJP ELECTRONICS	TJP-G64-ENC01	S	INCREMENTAL-ENCODER INTERFACE	£215	THREE OPTOISOLATED TWIN-TRACK ENCODER INPUTS; 16-BIT UP/DOWN COUNTERS
	TJP-G64-STEP01	S	STEPPER MOTOR/PULSE CONTROLLER	£220	FOUR PULSE COUNTERS; FOUR OPTOISOLATED PULSE TRAINS AND FOUR DIGITAL OUTPUTS; PROGRAMMABLE CLOCK FREQUENCIES

SPECIALIZED I/O BOARDS FOR II/OC/EUROBUS

DORSCH MIKROSYSTEM	HSADM	S	8-BIT VIDEO IMAGE DIGITIZER	DM 1980	10-MHz SAMPLE RATE; 1V/75 Ω VIDEO INPUT
	RME-15	S	RESISTANCE-TEMPERATURE-DETECTOR INTERFACE	DM 1850	15 PT100-COMPATIBLE INPUT CHANNELS
	ACHSEN-MODULE	S	3-AXIS DC MOTOR CONTROLLER	DM 1380	ONE 16-BIT COUNTER, TWO DIGITAL INPUTS, AND A 12-BIT D/A OUTPUT PER AXIS
EKF-ELEKTRONIK	10935-VAD	S	8-BIT VIDEO IMAGE DIGITIZER	DM 1180	5-MHz SAMPLE RATE
PEP MODULAR COMPUTERS	PVM	S	POSITION/VELOCITY SENSE MODULE	DM 1980	SIX SINGLE OR THREE DUAL OPTO-ISOLATED INCREMENTAL-ENCODER INPUTS; 16-BIT RESOLUTION
	TSM	S	THERMOCOUPLE AMPLIFIER	FROM DM 957	4, 8, 12, OR 16 INPUTS FOR J OR K THERMOCOUPLES; 10-mV/°C ANALOG OUTPUT

SPECIALIZED I/O BOARDS FOR THE STE BUS

DATABETA	DBSSE-1	S	SHAFT-ENCODER INTERFACE	~ £200	THREE SHAFT-ENCODER INPUTS; 40V OPTOISOLATED INPUTS
	DBSRC-1	S	DUAL-STEPPER-MOTOR CONTROLLER	~ £300	ONBOARD 6809 μ P AND MOTOR-CONTROL FIRMWARE; SHAFT-ENCODER INPUT
	DBSRC-2	S	DC-SERVO-MOTOR CONTROLLER	~ £300	ONBOARD 6809 μ P AND MOTOR-CONTROL FIRMWARE; SHAFT-ENCODER INPUT

KEY:

— INFORMATION NOT PROVIDED
D DOUBLE HEIGHT
S SINGLE HEIGHT

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Thus, Heraeus Vacuum Drying Ovens are of special interest from the point of view of economic efficiency.

Also, the absence of air prevents oxidation of the material being treated.

By the use of an inert gas, oxidation can also be prevented at normal pressure.

In addition, with no air and no convection in the oven, the material is largely protected from contamination by particles.

Examples of Applications

Electronics Industry:

Drying of wafers, also in N_2 atmosphere; testing, ageing and tempering of components with exclusion of air.

Chemical, Pharmaceutical and Cosmetics Industries:

Gentle drying of powders, granulates, plant material, hormones, vitamins, etc.; degassing of plastic parts.

... and we offer you high-quality Vacuum Drying Ovens allowing you to profit by these advantages

Models VTR

- Cylindrical inner casing of aluminium
- Shelves of aluminium
- Door with observation window, spring-mounted and easily adjustable
- Mechanical controller, infinitely adjustable
- Adjustable temperature limit cut-out



Models VT

- Rectangular inner casing of stainless steel
- Shelves of aluminium
- Door with observation window, spring-mounted and easily adjustable
- Inside of window provided with a film of gold to minimize heat losses
- Electronic on-off controller and programmer
- Adjustable temperature limit cut-out



Models VT/EKP

- Rectangular inner casing of stainless steel
- Permanently installed shelves of stainless steel, heated directly; temperature of each shelf controllable individually
- Door with observation window, spring-mounted and easily adjustable
- Inside of window provided with a film of gold to minimize heat losses
- Electronic on-off controllers; programmer on request



Technical Data

Type	VTR 5022	VTR 5036	VTR 5050	VT 5042 EK	VT 5050 EK	VT 5042 EKP	VT 5050 EKP
Volume, litres	11	48	138	53	130	53	130
Number of shelves	1	2	2	2	3	2	3
Total useful area, cm ²	500	2660	5820	1275	2290	1200	1950
Temperature range, °C	40-180	40-180	40-180	t _A -250 ¹⁾	t _A -250 ¹⁾	t _A -400 ¹⁾	t _A -400 ¹⁾
Time required to heat to the rated temperature, min.	45	140	170	140	190	70	70
Rated power, kW	0,60	1,20	2,00	1,35	1,90	1,50	3,10
Rated voltage/frequency	All the models are rated for 220 V A.C., 50/60 c/s.						

¹⁾ Lower temperature limit, t_A = 5 °C above room temperature



Design and manufacture according to the regulations governing Pressure Vessels

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- ☐ your range of Vacuum Drying Ovens (brochure PEW-B 3)
- ☐ your entire range of Heating Ovens (catalogue PEW-A)

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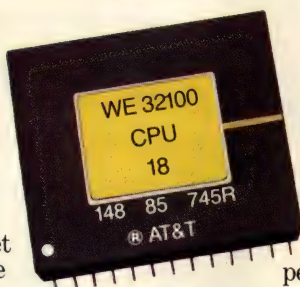
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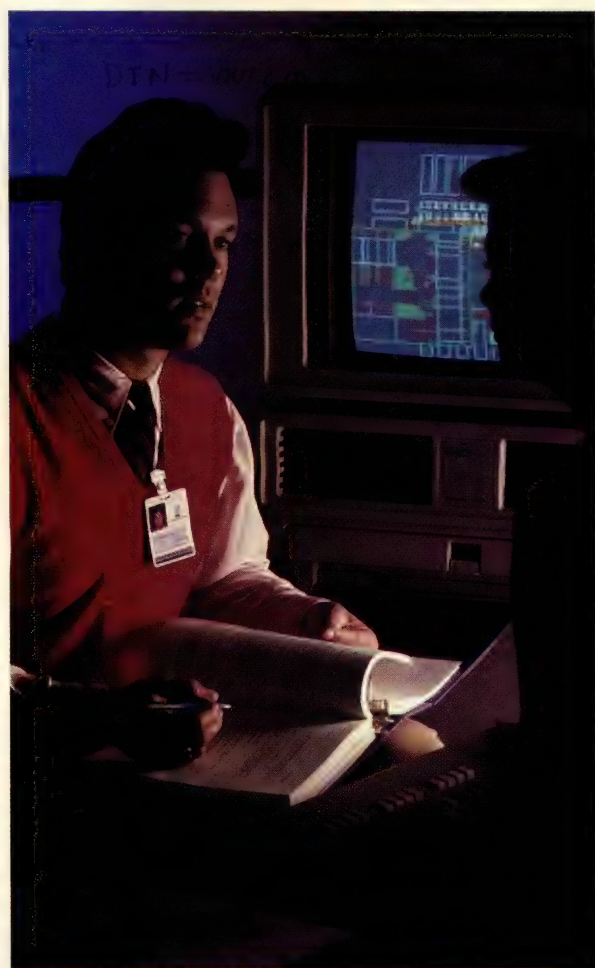
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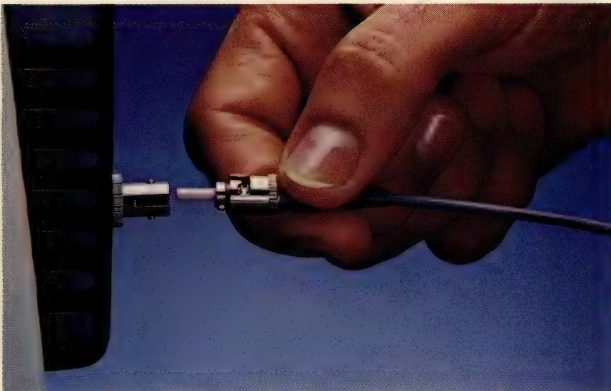


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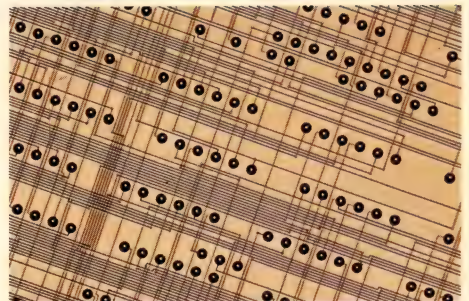
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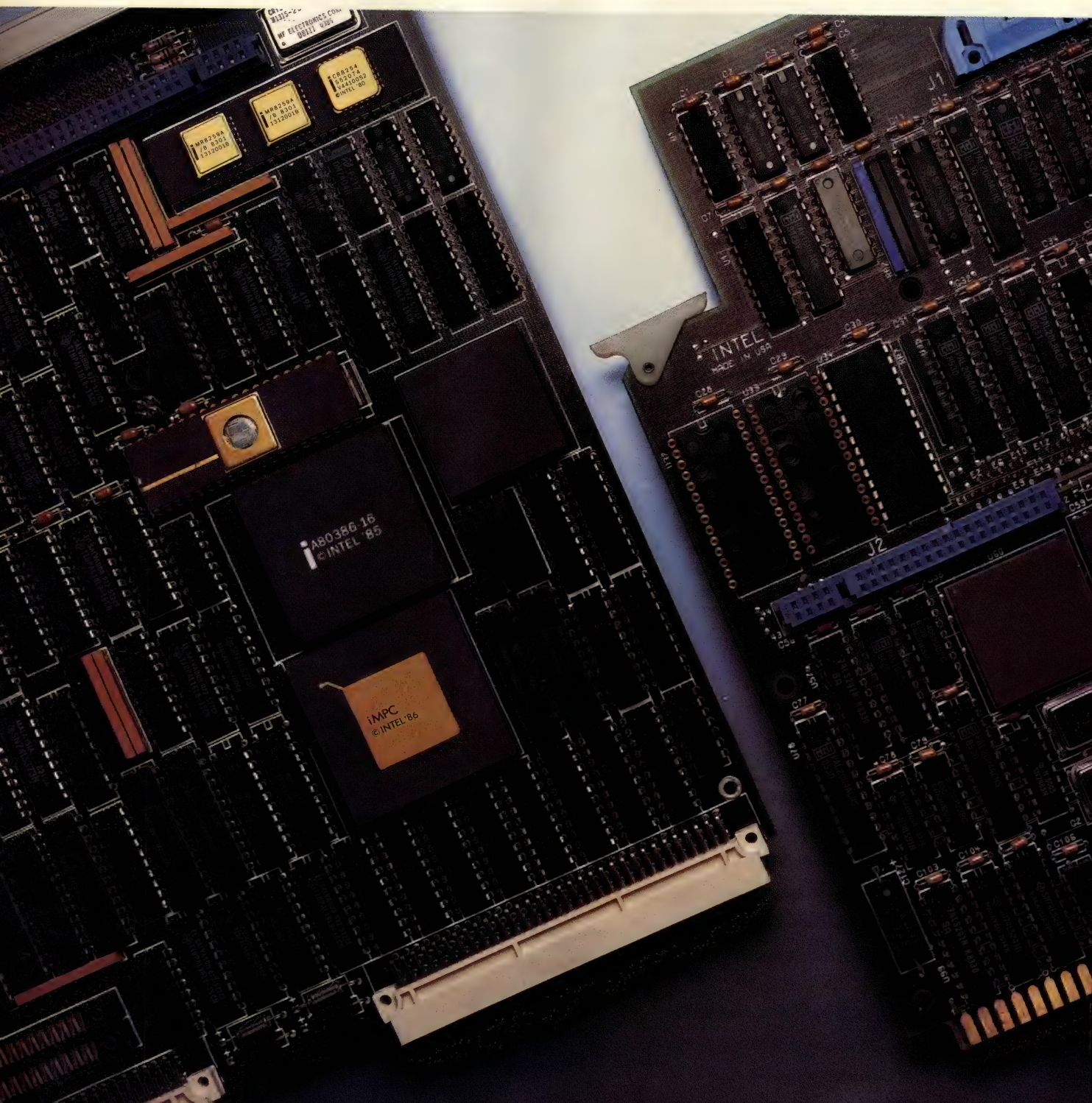
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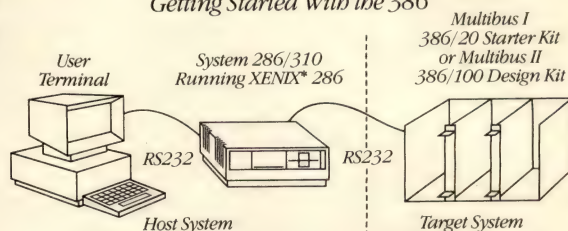
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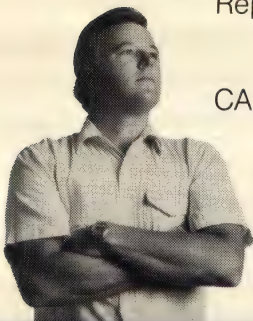
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Port technique allows complex-impedance emulation and scaling

Using a quad op amp and discrete components, you can create a bidirectional port that's terminated by an arbitrary complex impedance. Both single-ended and balanced versions of the port are based on a single network of passive components. What's more, you can use standard-value components and scale them to the desired level.

Howard Sinberg, Aptek Microsystems

To communicate over a transmission line, you must create a circuit (port) that functions as a transmitter or a receiver (or both) while presenting to the line a specific impedance—usually a value matched to that of the line. Building such a circuit—one that fulfills these functions simultaneously—poses a problem that's typical in telecommunications systems and that also may arise at the signal interface between separate pieces of equipment.

The simplest and most obvious solution is to insert the desired impedance network at the port terminal, in

series with a low impedance output and in parallel with a high impedance input. This approach has several shortcomings, however: First, the passive components may be physically large and require nonstandard values. Next, you may require two networks instead of one to build a balanced, or differential, port—each having one-half of the desired impedance value. Furthermore, the need for overload protection may impose high-voltage ratings and other secondary requirements on the circuit components.

A better technique is to remove the network from the port's terminal and place it in a feedback loop. Nevertheless, this arrangement presents new problems: You lose the simple relationship between your network and the desired port impedance because the port now includes a finite impedance from the circuit facing the port. Consequently, you must make complex calculations if it becomes necessary to change the port impedance.

Complex-impedance emulator solves problems

You can eliminate these problems with a complex-impedance emulator. Such an emulator uses a single network (Z_R in Fig 1a) in both its single-ended and balanced versions, and it negates the finite impedances facing the port. The port may exhibit either the impedance of the network or that of the network scaled by a

The complex-impedance emulator requires only a single reference network in either its single-ended or balanced version and negates finite impedances facing its port.

real constant, which lets you use standard-valued components in realizing a nonstandard impedance value.

The single-ended emulator in **Fig 1a** presents to the port terminal an emulated impedance Z_T , equal to the reference impedance Z_R or equal to Z_R times a scaling constant. The input and output ports allow you to couple signals to and from the Z_T terminal. Note that the circuit has two major feedback loops (in addition to the minor loops local to each op amp).

A positive feedback loop (from the output of op amp IC_2 through R_F' to op amp IC_1) raises the apparent terminal resistance toward infinity, thereby excluding R_0 and R_I as components of Z_T . Then, the negative feedback loop (from the output of op amp IC_2 through R_S' , op amp IC_3 , and Z_R to op amp IC_1) lowers the terminal impedance to the desired magnitude (Z_T).

You need only three equations to make use of a single-ended emulator. (For more details of the emula-

tor's operation, see **box**, "How the emulator works".) First, calculate R_F' to negate the loading effects of R_0 and R_I :

$$R_F' = \frac{R_F R_I}{R_I + R_0}$$

Next, establish the desired terminal impedance:

$$Z_T = Z_R \left(\frac{R_0 R_S'}{R_F R_S} \right).$$

Note that $R_0 \times R_S' / (R_F R_S)$ is the factor that scales the reference network to achieve a given Z_T .

Finally, you only have to select R_S' if you need to transmit—ie, source a signal from the input port to the terminal port. When no external impedance is connected to the terminal (open circuit condition), the

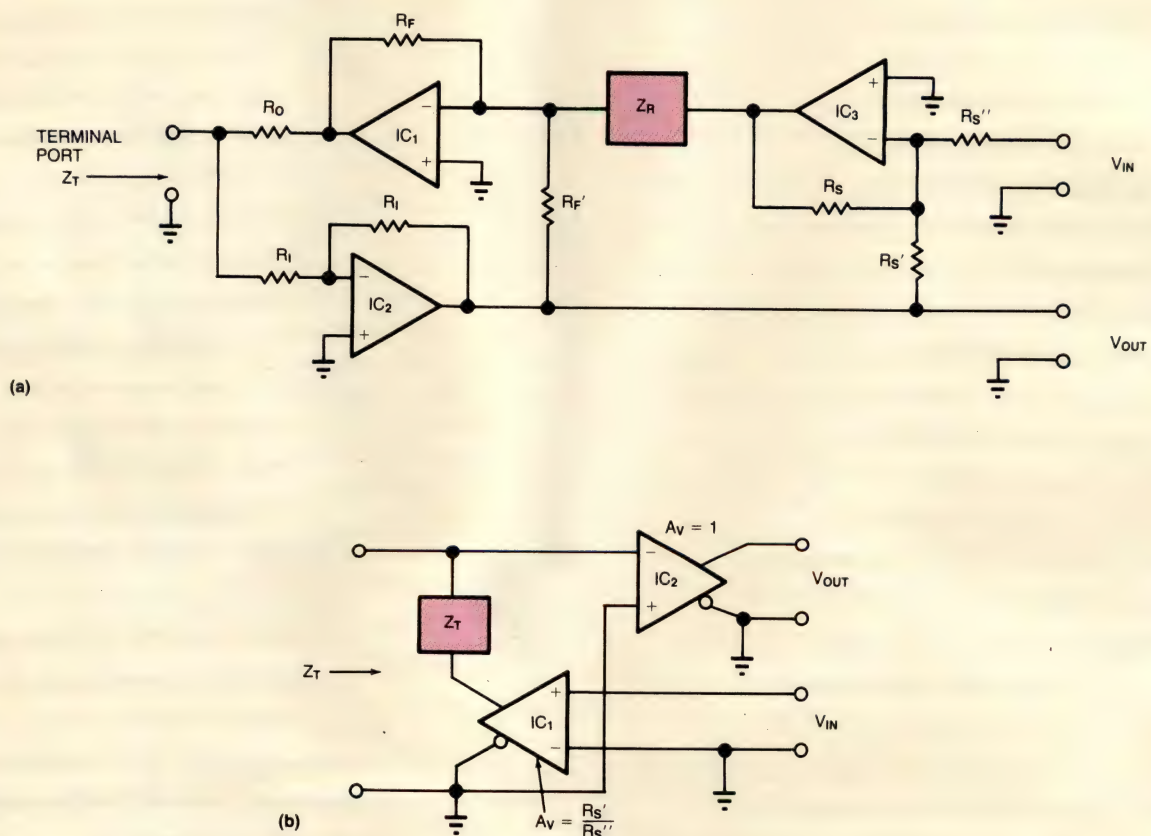


Fig 1—A single-ended impedance emulator (a) presents Z_R or KZ_R at the terminal port and allows transmission and reception via V_{IN} and V_{OUT} . A simplified version (b) is equivalent to a.

transfer function is $A_{VO} = -R_S'/R_S''$, where A_{VO} is the open-circuit voltage gain. On the other hand, if you load the terminal with Z_T , the output voltage is reduced by half: $A_{VT} = -R_S'/(2R_S'')$, where A_{VT} is the voltage transfer function for the emulator when terminated with its characteristic impedance.

As a practical example, consider emulation of a

simple network: a 150Ω and 830Ω resistor in series, with a 72-nF capacitor connected in parallel with the 830Ω resistor. (This network duplicates the impedance of a typical telephone line in Belgium, according to the agency that administers that country's telephone system.)

For convenience, use a $0.02\text{-}\mu\text{F}$ capacitor in place of

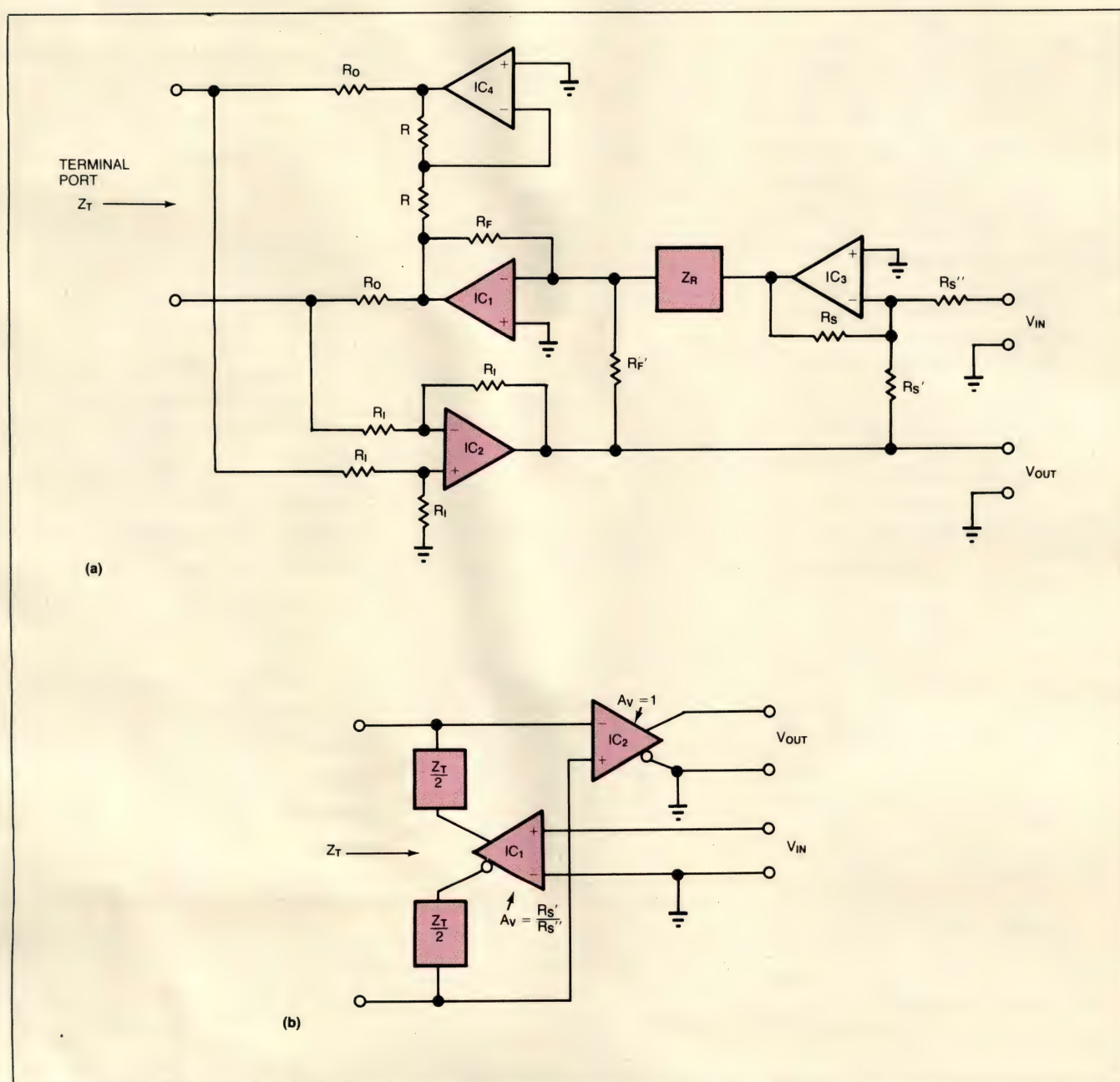


Fig 2—A differential impedance emulator (a) presents a balanced impedance at the terminal port. The circuit in b is a simplified version.

Consider emulation of a simple phone line: a 150Ω and 830Ω resistor in series, and a 72-nF capacitor connected in parallel with the 830Ω resistor.

the nonstandard 72-nF value. These values determine the scaling factor:

$$\frac{R_0 R'_S}{R_F R_S} = \frac{0.02 \times 10^{-6}}{72 \times 10^{-9}} = 0.278.$$

Similarly, the 150Ω resistor becomes 150/0.278, or 540Ω

(536Ω is the nearest 1% value), and the 830Ω resistor becomes 830/0.278 or 2986Ω (3.01 kΩ). Thus, the Z_R network (Fig 1) becomes a 536Ω and 3.01-kΩ resistor in series, with a 0.02-μF capacitor connected across the 3.01-kΩ resistor.

All that remains for the emulation to be complete is to select resistor values. If you arbitrarily set R_F, R_I,

How the emulator works

An impedance emulator (Fig A) scales the complex impedance of a reference network (Z_R) by an arbitrary constant and presents the result at its terminal port.

Assume that R_F'=R_F, R_I'=R_I, and R_S/R_S'=K, a constant. If the terminal port is forced to a voltage V_T, then the output of amplifier IC₁ is -V_T, the output of amplifier IC₂ is KV_T, and the output of amplifier IC₃ is V_T-KV_TR_F/Z_R. (The V_T term is from feedback loop 1 and the KV_TR_F/Z_R term is from loop 2.)

The voltage V_{RO} across resistor R_O is

$$V_{RO} = V_T - \left(V_T - \frac{KV_T R_F}{Z_R} \right) = \frac{KV_T R_F}{Z_R}.$$

If R_I is much greater than R_O, the terminal input current I_T is

$$I_T = \frac{V_{RO}}{R_O} = \frac{KV_T R_F}{Z_R R_O},$$

and the terminal impedance is

$$Z_T = \frac{V_T}{I_T} = \frac{Z_R R_O}{K R_F}.$$

Thus, the impedance to ground of the terminal port emulates the reference impedance (Z_R) times R_O/(K R_F), a constant.

The finite value of R_I, however, introduces an error by drawing current from V_T and lowering the effective terminal impedance. You compensate for this effect (Fig B) by adjusting the value of R_F'.

The current I_I should not

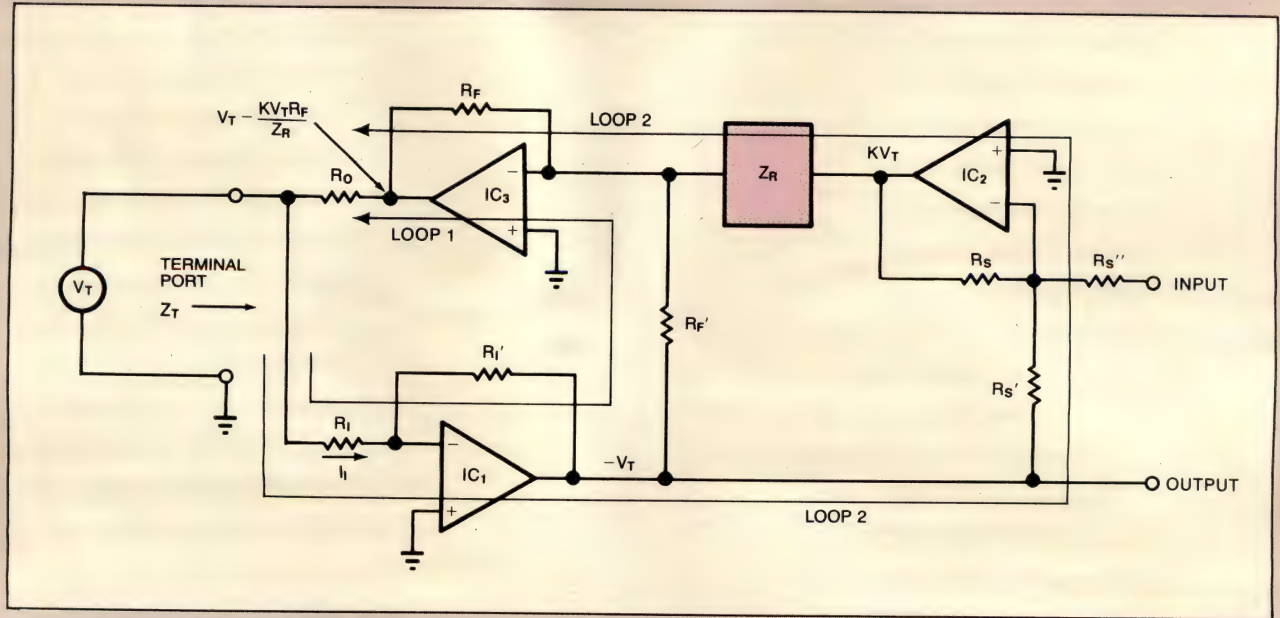


Fig A—An impedance emulator circuit presents Z_R (or Z_R times a constant) at the terminal port. The positive feedback loop 1 negates the unwanted effects of resistances R_O and R_I; the negative feedback loop 2 establishes the desired terminal impedance.

and R_S to 10 k Ω and R_O to 200 Ω , then

$$R_F' = \frac{R_F R_I}{R_I + R_O} = 9.804k$$

and

$$R_S' = \left(\frac{Z_T}{Z_R} \right) \left(\frac{R_F R_S}{R_O} \right) = 0.278 \left(\frac{100 \times 10^6}{200} \right) = 138.9k.$$

Once again, choose the nearest standard 1% values: 9.76 k Ω and 140 k Ω , respectively. You don't have to make any more calculations. Note that you never have to analyze the given network or measure its impedance at any frequency.

come from V_T ; it should instead come through R_O from the output of IC₃. Therefore, the component of IC₃'s output caused by loop 1 must be $V_T + I_1 \times R_O$, where $I_1 \times R_O$ is the voltage drop across R_O . Accordingly,

$$\frac{R_F}{R_F'} = 1 + \frac{I_1 R_O}{V_T}.$$

But $V_T = I_1 \times R_I$, so

$$\frac{R_F}{R_F'} = 1 + \frac{I_1 R_O}{I_1 R_I} = \frac{R_I + R_O}{R_I}.$$

Hence, $R_F' = R_F R_I / (R_I + R_O)$, rather than $R_F' = R_F$ as was first assumed. The only purpose of the positive feedback loop-1, in fact, is to eliminate the effect of resistances R_O and R_I on the terminal impedance. Then, the negative feedback loop 2 introduces the desired terminal impedance $Z_R R_O / (K R_F)$.

When the impedance emulator operates as a receiver/transmitter, it's clear that a voltage V_{TR} at the terminal port will produce a voltage $-V_{TR}$ at the output terminal (receiver mode). To determine the transfer function for coupling signals through the emulator to the terminal (transmit mode), assume that a voltage V_{IN} applied to the input terminal

will produce a voltage V_{TT} at the terminal port.

Further, if the terminal port is not externally terminated, the only current through R_O is I_1 . Assuming for simplicity that this current is zero, V_{TT} appears at the output of amplifier IC₃. The sum of input currents to IC₃ must equal $-V_{TT}/R_F$. Because R_F' approximately equals R_F , the current through R_F' equals $-V_{TT}/R_F'$. Therefore, virtually all of IC₃'s input current comes through R_F' , and none comes through Z_R . Consequently, amplifier IC₂'s output must be zero,

and its net input current must be zero. That is, V_{IN}/R_S'' must equal $-V_{TT}/R_S'$. Therefore, the voltage gain with an unterminated terminal is

$$\frac{V_{TT}}{V_{IN}} = -\frac{R_S'}{R_S''}.$$

Finally, the circuit in transmit mode is emulating an impedance Z_T , so the gain, when loaded by an impedance Z_L , is

$$\frac{V_{TT}}{V_{IN}} = -\frac{R_S'}{R_S''} \left(\frac{Z_L}{Z_L + Z_T} \right).$$

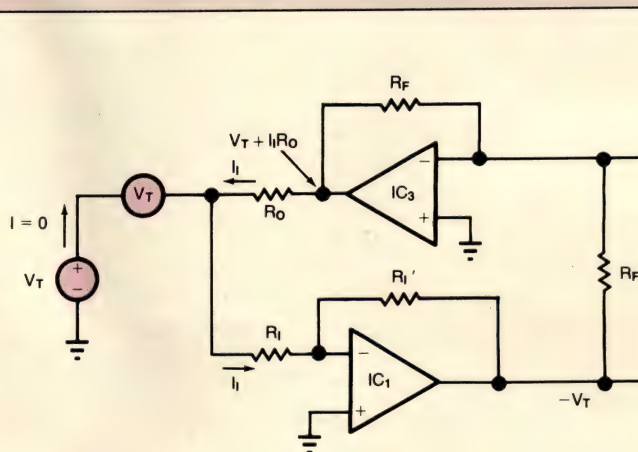


Fig B—To eliminate the loading effects of R_I and R_O , loop 1 produces a voltage V_T (equal to the applied voltage) at the terminal port. Hence, no load current is drawn from the source V_T .

Take care to minimize stray capacitance in the circuit layout because the resulting phase shifts will cause impedance errors that increase with frequency.

Using this circuit technique, you can also design a differential-mode impedance emulator (Fig 2a) that's suitable for use as an interface to a balanced transmission line. The emulated impedance appears at the Z_T port, balanced with respect to ground. For the differential emulator, only the design equation for R_F' differs from the equations used in the single-ended version:

$$R_F' = \frac{2R_F R_I}{R_I + R_O}$$

Note that the positive feedback loop from IC_2 through R_F' to IC_1 (Figs 1a and 2a) has a gain of one. If the terminal port is not loaded and Z_R is open or disconnected, the loop will be unstable and may oscillate.

The differential impedance emulator is suitable for measuring the return loss between a reference network (Z_R) and any external circuit (Fig 3). Return loss (RL) is a figure of merit that indicates the degree of equality for two impedances at a given frequency:

$$RL = 20 \log_{10} \left| \frac{Z_R + Z_T}{Z_R - Z_T} \right|$$

where Z_R and Z_T are the complex impedances of the reference network and the circuit being tested, respectively.

Component values in Fig 3 provide a terminal impedance equal to that of the reference network. When you connect an external circuit with the same impedance, the output of op amp IC_1 is equal in magnitude, but opposite in phase, to that of op amp IC_{5A} . The resulting currents in R_A and R_B are equal and opposite, causing a zero output (V_{OUT}). Any impedance mismatch produces a voltage at V_{OUT} , yielding a return loss of V_{IN}/V_{OUT} , expressed in decibels.

To calibrate the return-loss measuring circuit, remove the reference network and connect a signal generator across the tip and ring terminals. Adjust R_1 so that $V_1 = V_2$. Next, replace the reference network, apply an input signal (V_{IN}), and adjust R_2 for the correct termi-

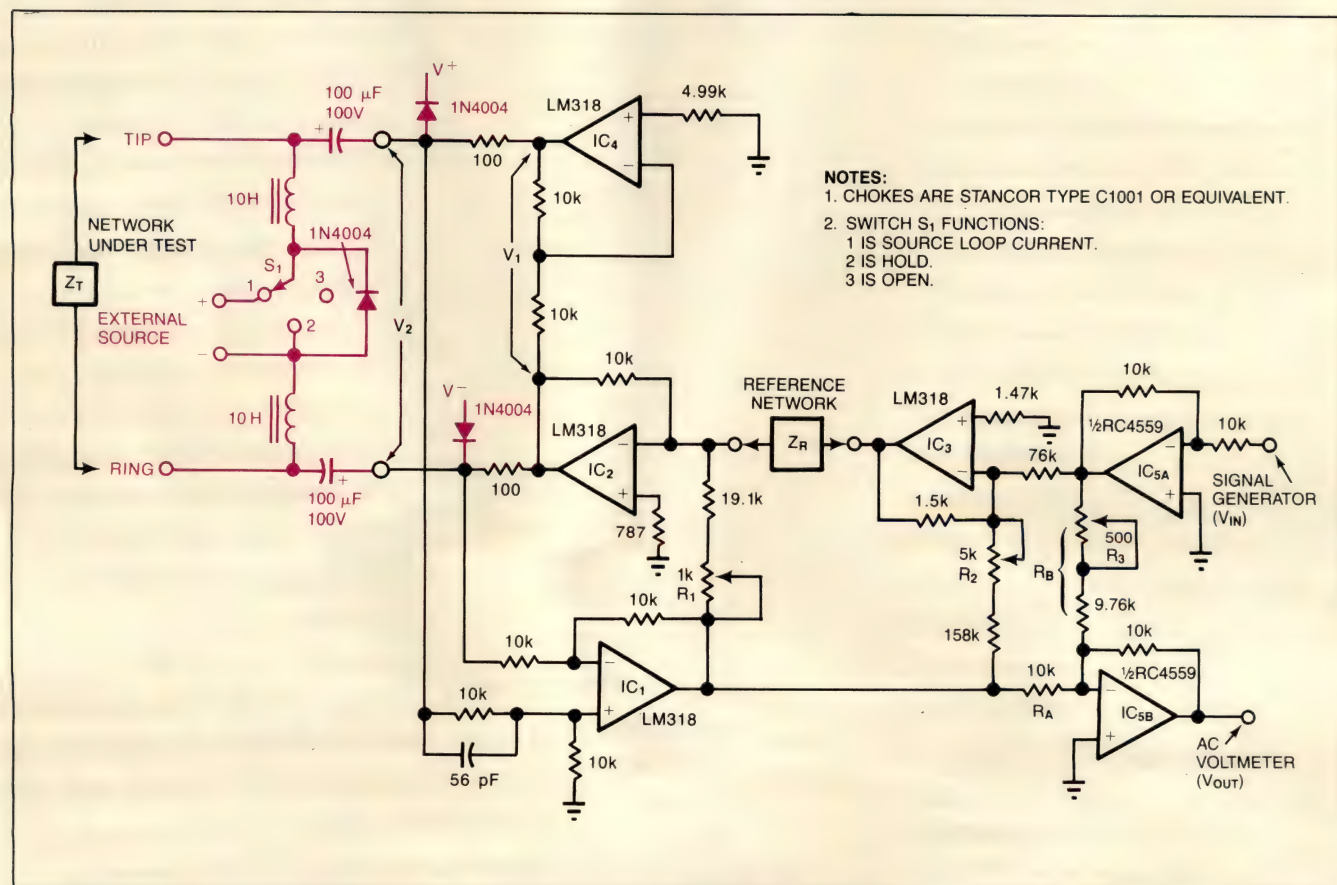


Fig 3—This return-loss measuring circuit includes a differential impedance emulator. The components in color are required only for measurement of active telephone loops.

Impedance by computer analysis

Computer programs for ac analysis let you determine gain or loss, phase shift, and other quantities, but few provide for the direct measurement of impedance. All such programs include independent current sources, however, which allow you to measure impedance indirectly.

Impedance is defined by Ohm's law ($Z=V/i$), so if i is a unit current (ie, one ampere), then V is numerically equal to Z . You can measure the impedance of a 1-port network by connecting a computer-simulated current source to the computer-simulated network (Fig A.) Further, you can measure any port of an n-port network, and note the effects as you change conditions at the other ports. Depending on the program, your measurement can include the

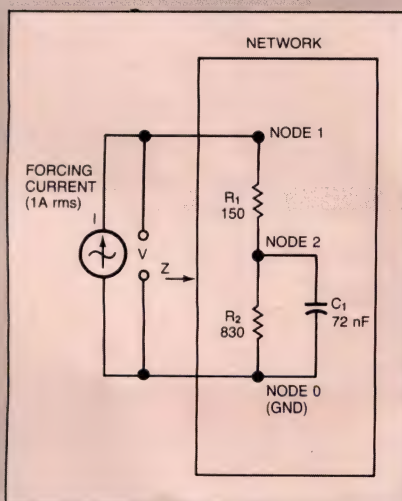


Fig A—You can measure the impedance Z by simulating the current source and network on a computer. Simulation allows a 1A-rms current excitation, making Z numerically equal to V .

real and imaginary components of an impedance, or its magnitude and phase angle, or both.

In Fig B, a Spice program listing and its output illustrate the measurement of impedance for a simple 3-element network. Because some programs (such as MicroCap) give the voltage only in decibel form, you must convert to find Z : $Z=10^{\alpha}/20$, where α is the decibel expression for

output amplitude.

You can make this measurement on active as well as passive circuits, and the computer lets you push amperes of current, even into the base of a small-signal transistor. Thus you won't be embarrassed by the smoke that would rise from your workstation if you tried this technique with real hardware.

PRIME SPICE 2E.3C(21DEC79)

0 IMPEDANCE MEASUREMENT
0 INPUT LISTING TEMPERATURE = 27.000 DEG C
0

11 0 1 AC 1
* 1 AMPERE AC CURRENT INTO NODE 1.
.PRINT AC VR(1) VI(1) VM(1) VP(1)
* PRINT REAL, IMAGINARY, MAGNITUDE, PHASE OF IMPEDANCE AT NODE 1.
R1 1 2 150
R2 2 0 830
C1 2 0 72N
MEASURE AT 200-HZ INTERVALS, FROM 200 HZ TO 3400 HZ.
.END

NODE	VOLTAGE	NODE	VOLTAGE
(1)	0.0000	(2)	0.0000

TOTAL POWER DISSIPATION 0.00D-01 WATTS

IMPEDANCE MEASUREMENT

FREQ	VR (1)	VI(1)	VM(1)	VP(1)
2.000D 02	9.753D 02	-6.198D 01	9.773D 02	-3.636D 00
4.000D 02	9.617D 02	-1.219D 02	9.694D 02	-7.225D 00
6.000D 02	9.399D 02	-1.780D 02	9.566D 02	-1.072D 01
8.000D 02	9.113D 02	-2.287D 02	9.396D 02	-1.409D 01
1.000D 03	8.774D 02	-2.731D 02	9.190D 02	-1.729D 01
1.200D 03	8.399D 02	-3.109D 02	8.956D 02	-2.031D 01
1.400D 03	8.003D 02	-3.418D 02	8.703D 02	-2.313D 01
1.600D 03	7.599D 02	-3.664D 02	8.436D 02	-2.574D 01
1.800D 03	7.197D 02	-3.851D 02	8.163D 02	-2.815D 01
2.000D 03	6.807D 02	-3.985D 02	7.888D 02	-3.035D 01
2.200D 03	6.433D 02	-4.075D 02	7.616D 02	-3.235D 01
2.400D 03	6.080D 02	-4.128D 02	7.349D 02	-3.417D 01
2.600D 03	5.750D 02	-4.149D 02	7.090D 02	-3.581D 01
2.800D 03	5.442D 02	-4.145D 02	6.841D 02	-3.729D 01
3.000D 03	5.158D 02	-4.121D 02	6.602D 02	-3.862D 01
3.200D 03	4.896D 02	-4.081D 02	6.374D 02	-3.981D 01
3.400D 03	4.656D 02	-4.029D 02	6.157D 02	-4.087D 01

JOB CONCLUDED

Fig B—This Spice routine uses independent current sources to measure the impedance of the network in Fig A. The program lists the real and imaginary components (V_R and V_I) as well as magnitude and phase (V_M and V_P).

Because terminal impedance is not determined solely by the battery-feed resistors, this circuit can source 20 mA into a 1900Ω loop.

nal impedance. (One way to do this is to connect a Z_T network identical to Z_R . When the emulator's terminal impedance is properly adjusted for the frequency range of interest, the terminal voltage will be reduced by one-half when Z_T is connected.) Finally, adjust R_3 for a zero output (V_{OUT}) when the emulator is properly terminated ($Z_T = Z_R$).

Take care to minimize stray capacitance in the circuit layout because the resulting phase shifts will cause impedance errors that increase with frequency. These effects can be compensated for (along with the op amps' bandwidth limitations, to some degree) by using small capacitors in the offending stages—note the 56-pF capacitor near IC_1 in Fig 3. Because the emulated impedance depends strongly on the gain and phase characteristics of the op-amp stages, you should choose op amps with high open-loop gain and good high-frequency response.

The circuit can measure return loss below 50 dB when comparing matched impedances, and it offers a

wider frequency range than some commercial return-loss test sets. It can, for example, measure return loss at 12 and 16 kHz for metering-pulse applications.

In addition to using a differential emulator to measure return loss, you can modify it for use in a telephone-line interface (Fig 4) such as that found in a PBX. The SLIC (subscriber-line interface circuit) is a hybrid microcircuit that provides a 2- to 4-wire conversion, ie, it separates the loop's bidirectional signals into unidirectional receive and transmit paths. The SLIC also provides current to the station loop, monitors instrument hook status, and performs other tasks.

The circuit in Fig 4 emulates an impedance of 600Ω in series with a 2.16-μF capacitor, and its transhybrid loss is optimized for a termination consisting of 350Ω in series with the parallel combination of a 1-kΩ resistor and a 210-nF capacitor (these are the standard termination and balance impedances for PBX off-premises extensions in the US). Single-frequency return loss is better than 20 dB from 300 to 3400 Hz, and echo return

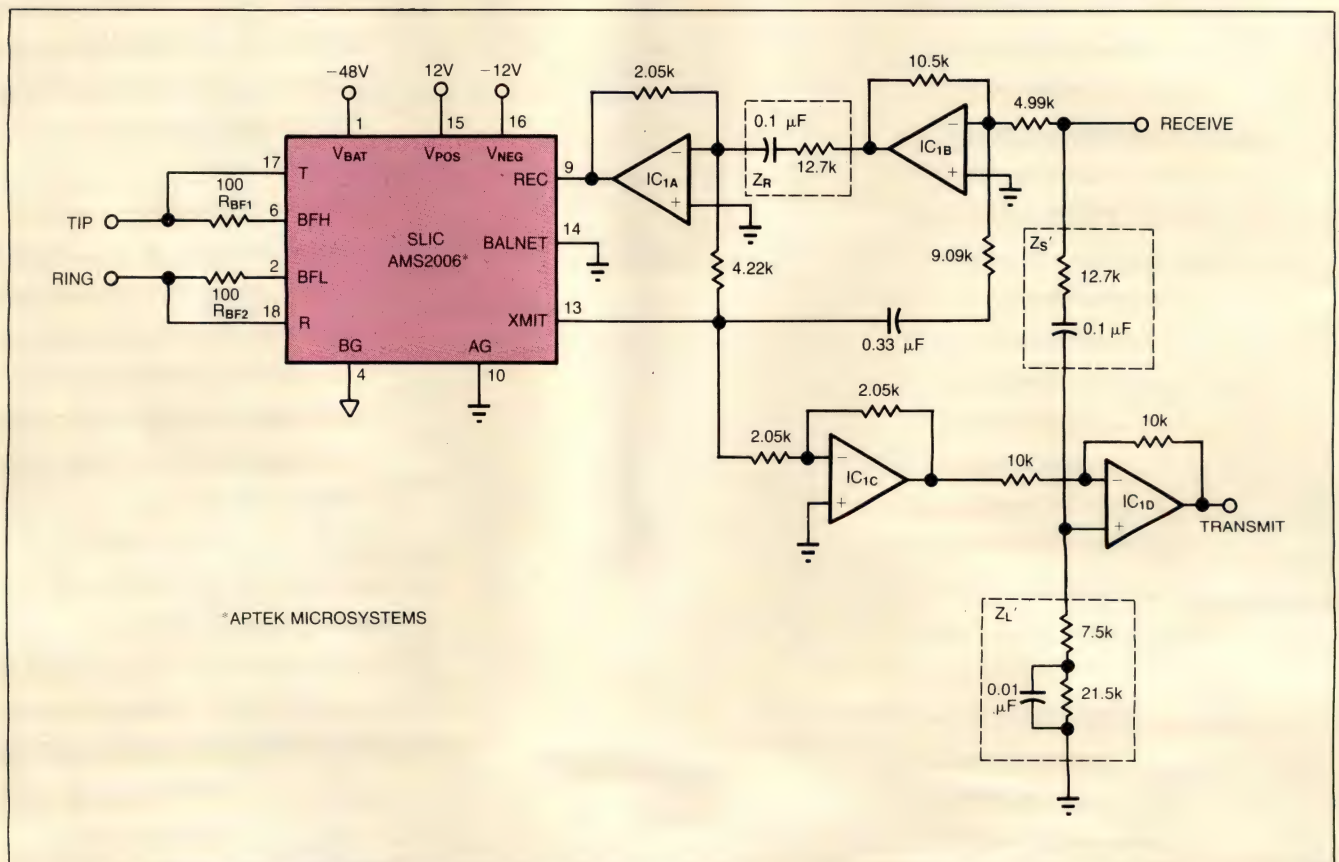


Fig 4—A modified differential impedance emulator and the SLIC hybrid microcircuit together provide a line transceiver with a controllable complex impedance.

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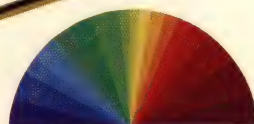
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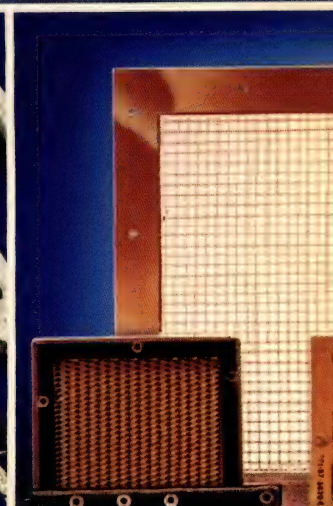
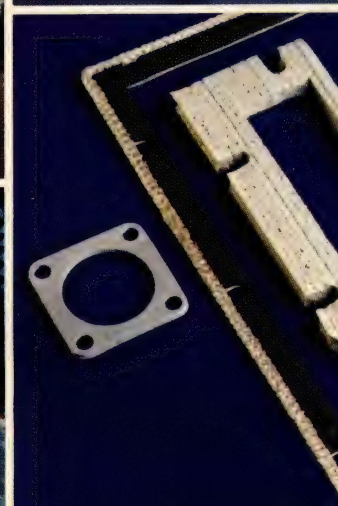
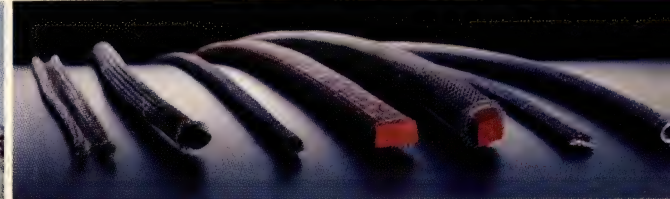
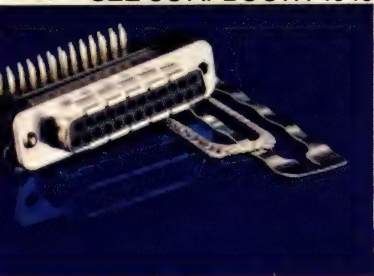
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loss is 30 dB. Adding a quad op amp and other components to the SLIC results in a line circuit with three advantages over the conventional telephone-line interface.

First, the line circuit can present any impedance to the loop. Moreover, you can choose the scaling factor so that capacitors in the emulated network are small and have standard values.

Second, you can accommodate a balance impedance that's different from the termination impedance. For example, consider the simple case of a 600Ω line circuit connected to a 600Ω telephone through a 1000Ω loop. Using these values, the line circuit sees a 1600Ω termination and has a transhybrid loss of less than 7 dB. The network's Z_S' and Z_L' in Fig 4 replicate impedances at the SLIC terminal and the line, respectively, such that

$$\frac{Z_S'}{Z_L'} = \frac{Z_S}{Z_L}$$

You can scale Z_S' and Z_L' by any convenient factor (same factor for each, of course). Note that if these impedances are replicas of each other (ie, their quotient has real terms only), then they may be replaced by resistors.

Finally, increased loop current is available for off-premises extensions. Because the terminal impedance is not determined solely by the sum of the battery-feed resistors R_{BF1} and R_{BF2} , you can use resistor values smaller than the customary 300Ω. As a result, the circuit can source a given current into a longer loop. This circuit (Fig 4) can source 20 mA into a 1900Ω loop, but be careful: The lowered resistance allows a higher surge current during fault conditions.

EDN

Author's biography

Howard Sinberg is a principal engineer with Aptek Microsystems (Deerfield Beach, FL), where for the past 1½ years he has designed hybrid circuits for telephony. His earlier duties at Siemens (Boca Raton, FL) included the design of telephone interface circuits. Howard holds three patents. He is a member of Mensa and enjoys word games, listening to classical music, and brewing his own beer.



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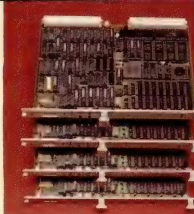
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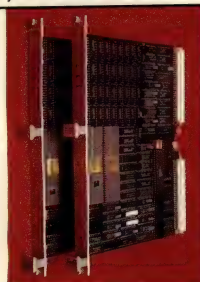
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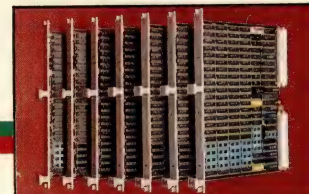
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MEM-3 6MB
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Parity or Error Correction
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Parity or Error Correction
16 bit Data, 24 bit Address

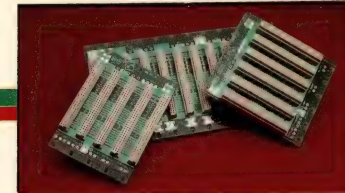


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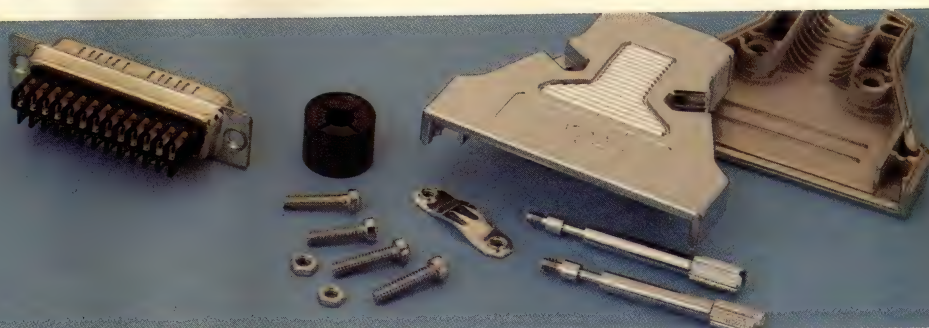


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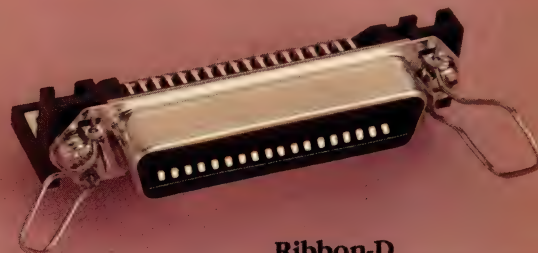
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CIRCLE NO 120

Innovative designs yield small, efficient switchers

Designing switching power supplies isn't always a routine job. Sometimes your specifications call for special supplies of extremely small size combined with very high efficiency and the ability to accept wide variations in input voltage.

Stephen S Banfalvi, *Bell Northern Research*

Lessons learned in designing supplies for demanding telecommunications applications can also prove useful in other circumstances because telecommunications equipment must meet stringent safety, reliability, EMI, and input-voltage requirements. In this article, you'll confront six switching supplies, similar only in that they all are unconventional designs and are capable of handling wide input voltages. By examining these circuits, however, you can apply their concepts to your particular application—and perhaps avoid a headache or two. Furthermore, these supplies use commonly available, multisourced (where possible) components. For example, though some of the switchers work at very high frequencies, you don't need any special magnetic components: All the transformer cores are available from Siemens, Ferroxcube, and TDK.

Fig 1 shows a supply that accepts input voltages of 19 to 75V and that furnishes 12 to 15V at 100 mA. The

supply's inputs and outputs are isolated, and its switching frequency is approximately 150 kHz. Further, this design is rugged and inexpensive. Zener diode D_1 regulates the power oscillator Q_2 while zener diode D_2 functions as a dissipative postregulator.

The circuit's efficiency and output voltage depend on the load. For small loads, D_2 dissipates most of the power (2W max). You should connect C_3 only if you require more than 50 mA in the 19 to 30V input range. You must not use C_3 at input voltages over 40V because it can deliver too much base drive to Q_2 and thus overheat the transistor. Q_1 is an external-enable switch. To start the supply, connect the enable input to the 0 input.

The unit is short-circuit proof; in case of a hard short at the output, oscillation stops and input current drops to about 10 mA. Also, because the supply is short-circuit proof, you can obtain any output voltage between 0 and 20V simply by using a different zener diode: If you want, for example, a 5V output, choose a 5V, 2W zener for D_2 .

Using surface-mount devices (SMDs), you can build this supply on a 2×1¼-in. ceramic substrate and plug it into a socket or solder it onto a pc board. If you use the circuit as a stand-alone power supply, you should make the input capacitor C_1 at least 22 μ F to prevent too much noise from feeding back into the input line.

Fig 2 shows a supply that is 85% (min) efficient. As is usual in telephony—but not so for the rest of the electronics industry—the common input/output line connects to the positive side of the input battery. The

Although power-supply design is usually a routine job, special requirements like extremely small size or very low cost can cause headaches for a designer.

2525 pulse-width modulator (PWM) chip operates at approximately 28V. A preregulator converts the -40 to -60V input to the -28V level needed by the PWM IC's ground pins. The 1N4148 diode in series with the 1N4711 zener diode in the preregulator transistor's base circuit provides temperature compensation for the preregulator.

Providing 30V from a 40V input requires a nearly 90% duty cycle from the PWM chip. To ensure such a duty cycle, you must use both driver outputs from the PWM chip. The chip operates in a push-push mode whereby both of the chip's outputs drive parallel-connected FETs via a small driver transformer. The 2:1 transformer ratio ensures a maximum 14V gate drive for the FETs. Although using high-performance output transistors and catch diodes seems unnecessarily expensive for outputs of only 1.5A, the high speed and low internal resistance of the IRF540 FETs and the fast recovery and low forward drop of the MUR1515 diode result in an efficiency of better than 90% at full load, thereby justifying the cost of these components.

An MC3423 monitor IC, set to 34V, provides over-voltage protection by triggering the crowbar SCR. When the crowbar SCR switches on, it blows an

external 2A fuse. The supply runs at about 75 kHz. Because of its high efficiency, you can build it on a small pc board or ceramic substrate. If you build it on a small pc board, the FETs, the preregulator transistor, and the catch diode will need a cooling fin. If you use a ceramic substrate, a surface area of 8 to 10 in² will satisfactorily dissipate the loss of approximately 4W.

Miniature converter is efficient, too

The power supply in Fig 3 delivers 5V to a logic circuit, takes up very little board real estate, and achieves 80% (min) efficiency. A switching frequency of 140 kHz ensures the supply's small size. In order for such a small supply to achieve such high efficiency, you must use very little energy for housekeeping chores. The solution is to make your own PWM using low-power, discrete components. This design exhibits 83% efficiency at 200-mA load. You can synchronize this design to an external frequency as high as 160 kHz. Be sure that the free-running frequency is at least 10% lower than the synchronization frequency.

The control circuits include a pair of LM293 dual comparators. The comparators together consume about 2 mA—a fraction of the power consumed by any ready-

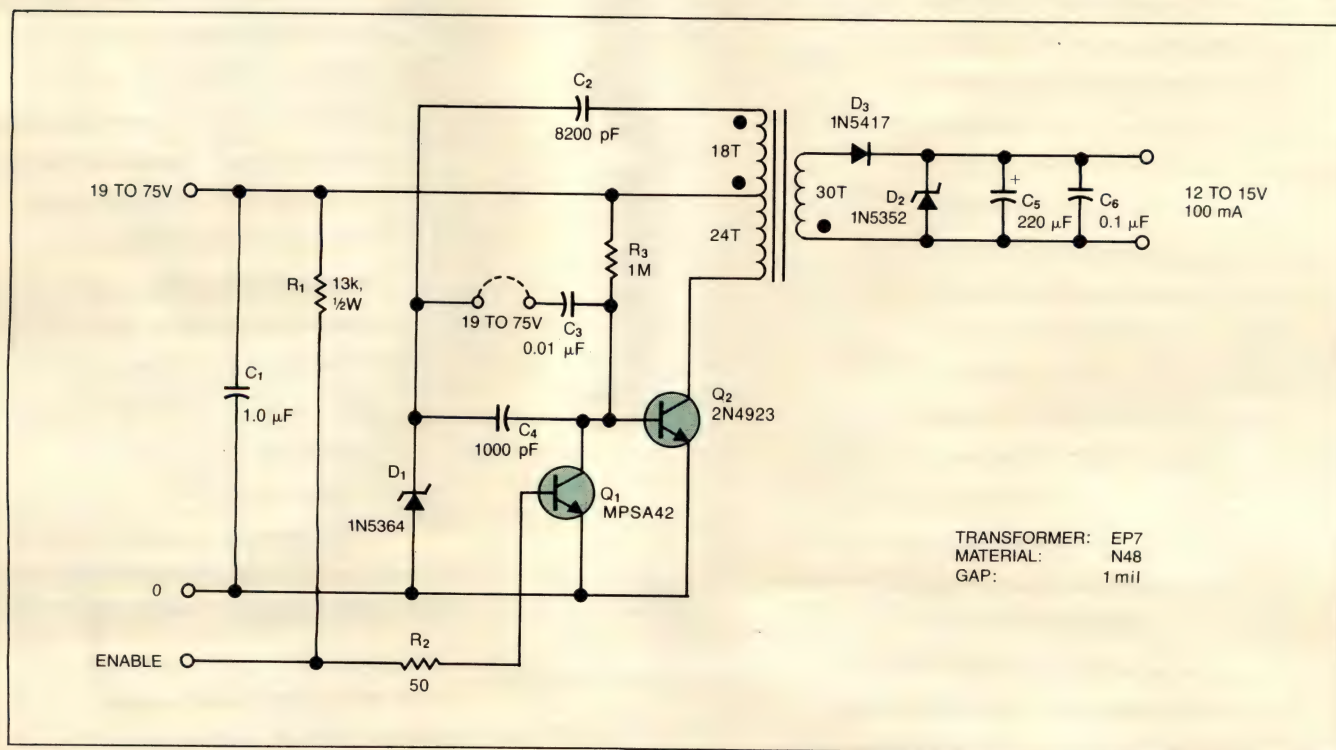


Fig 1—Accepting input voltages from 19 to 75V, this supply's efficiency depends on the load because zener diode D₂ dissipates most of the power under light loads.

If you use ceramic substrates, a relatively small surface area will satisfactorily dissipate losses.

made PWM IC. The circuit uses two dual comparators instead of one quad comparator because two different power-supply levels actually energize the two chips. The first section of the PWM requires a well-regulated power source, which the two 2.5V TL431 precision regulators furnish (5V total). The FET drivers, on the other hand, need to be able to swing over the full 15V source and hence derive their power from the unregulated input directly. Further, the two dual comparators take up no more space than a quad device.

One-half of the first comparator serves as an oscillator whose noninverting input, biased to 2.5V, impresses a ramp on the timing capacitor; the other half of the first comparator is a sync buffer. The second pair of paralleled comparators compares the capacitor's ramp to the output; they are connected in parallel to provide more power to the low-impedance drivers Q_1 and Q_2 , which in turn drive the gate of a p-channel FET. The output goes through a small inductor wound on a 1/4-in.-diameter toroid. The catch diode is a Schottky diode with very low forward drop at this supply's power level. If you use SMDs, you can build the supply on a 2×3/4-in. pc board or ceramic substrate.

Miniature converter supplies 10W

The small and easy-to-make design in Fig 4 uses the Lambda 6320P PWM IC. This 14-pin part comprises

the PWM, a 2A Darlington output stage, and protection against thermal and electrical overload: If thermal or electrical overload overheats the supply, the chip simply stops working until it cools down enough to try again—no damage is done.

Using SMDs, you can build the 10W supply on a 2×1-in. ceramic substrate. Because of the supply's small cooling surface, the IC must have fins glued to its top. (Normally, the ground pins 3, 4, 5, 10, 11, and 12 conduct heat to a large area of foil on a large pc board.) With the cooling fin glued to the IC, the power supply operates in ambient temperatures to 30°C. For ambient temperatures higher than 30°C, you'll need some forced-air cooling or extended heat sinks attached to a metal surface.

The switching frequency with the given C_T will be around 75 kHz. Input and output capacitors are paralleled tantalum chip capacitors for low equivalent series resistance (ESR), and the supply should operate at substrate temperatures less than 70°C to ensure long life for the tantalum capacitors. You wind the output inductor on a 3/8-in.-diameter toroid and mount it on a small platform with the output capacitors underneath. Thus, the supply is only 1/2 in. thick and uses up very little real estate on the mother board.

Fig 5 depicts a power supply using a different PWM chip, the high-frequency Unitrode 3825. Using the

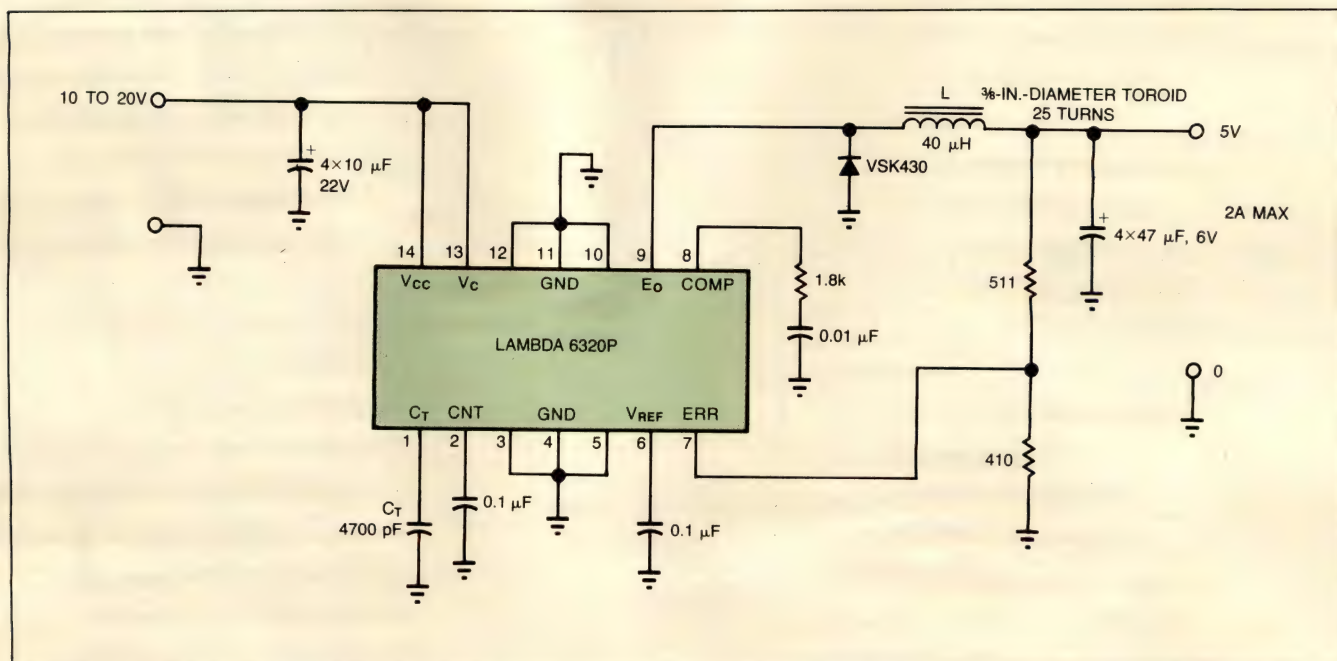


Fig 4—Using a commercial PWM chip such as Lambda's 6320P shrinks the amount of pc-board real estate that a supply consumes.

Then, the auxiliary winding on T_1 takes over the job of supplying power to the PWM IC.

[illegible]

EDN May 1, 1986

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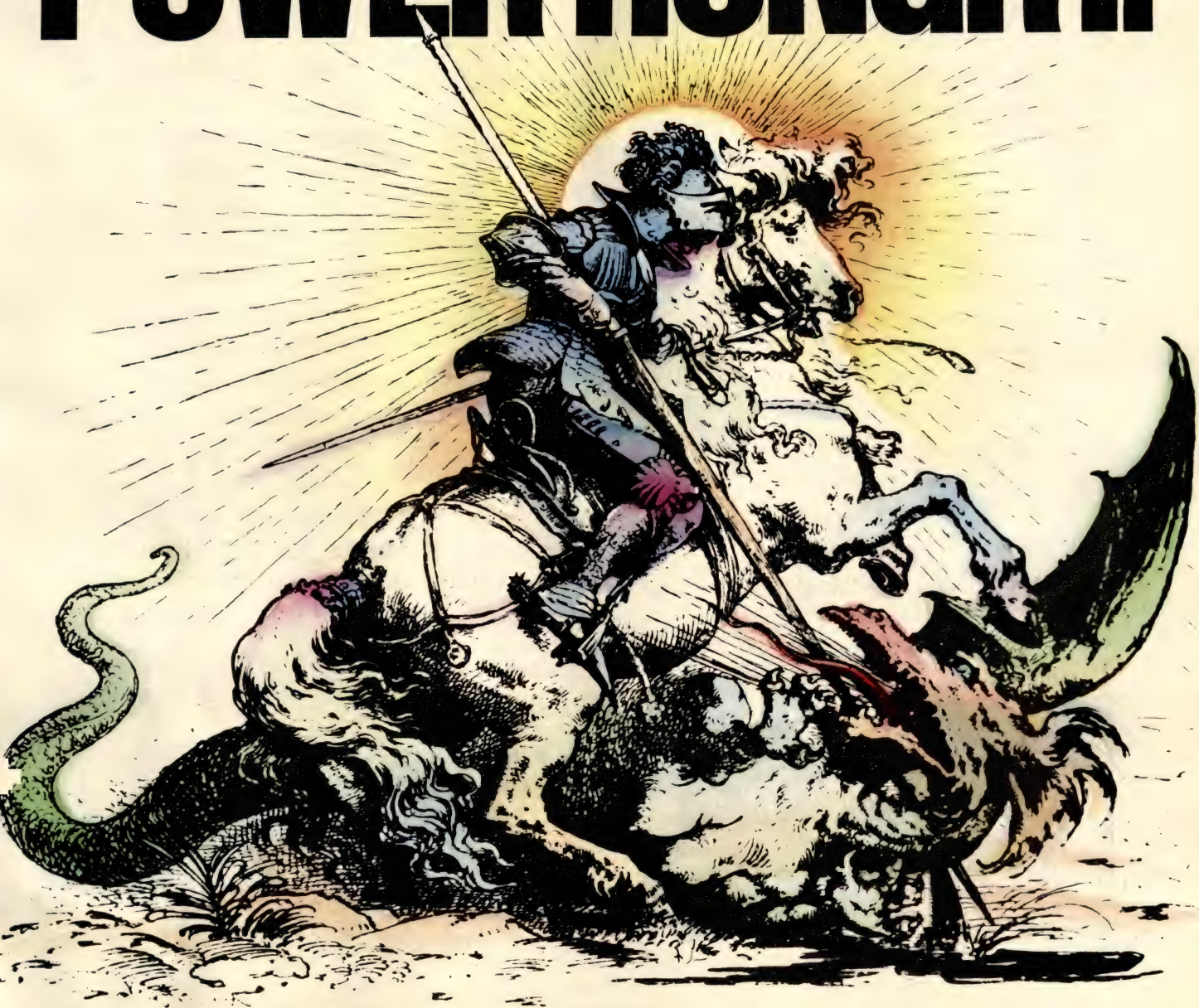
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CIRCLE NO 121

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Using high-performance components seems too expensive for low-current outputs, but these components enable you to build a more efficient, and hence smaller, supply.

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An optocoupler and a TL431 precision reference provide both isolation and the error signal. The optocoupler provides 1500V isolation—far higher than the coupling transformer. The standard test for the coupling transformer applies 500V ac for 5 sec.

For low output ripple at this supply's high frequency, the ESR of the filter capacitor must be extremely low. To achieve this low resistance, first deliver the output power on two wide, parallel strips of pc-board foil. Then solder five 47- μ F chip tantalum capacitors to the foil, side by side. This way, not only is the capacitance paralleled, but the ESRs are paralleled as well, resulting in a very low output ripple. In addition to the snubber network on the cathodes of the driver FETs, you should slip a small ferrite bead on the anode leads of the output Schottky rectifiers. The ferrite beads further reduce any voltage spikes, which otherwise might exceed the breakdown voltage of the rectifiers.

Using SMDs, you can build this supply on a $2\frac{1}{4} \times 2\frac{1}{4}$ -in. substrate. You must carefully observe all RF-design rules—for example, good decoupling and short interconnections. Efficiency at full load (6A) is approximately 80%, resulting in a 4 to 5W loss, which the substrate must dissipate. Without any extra cooling, the substrate can transfer about 2W/in² into the air with a 50°C temperature rise. This temperature rise means that, for ambient temperatures higher than 30°C, you must provide some air flow or you must attach the substrate to a heat sink or metal chassis.

Fig 6 shows a high-frequency switcher that you can build on a 4×8-in. baseplate (the baseplate acts as a heat-transferring medium). The control and output stages fit on a 4×4-in. ceramic substrate, and the ac-input section, EMI filter, rectifiers, and electrolytic capacitors mount on a pc board occupying the remaining half of the baseplate. The supply's height is less than 1 in.

The circuit employs the Unitrode 3825 in current-control mode and features a 200-kHz switching frequency and small magnetic components, and it allows easy filtering. The circuit also has an auxiliary supply that stops operation in case of overload and restarts automatically when the overload clears.

The circuit's input section includes a half-bridge rectifier and a pair of capacitors in series, which make up a voltage doubler. High-voltage and -efficiency requirements dictate the use of IRF840 FETs; the PWM IC drives the FETs via a small transformer. The output

rectifier exhibits a low forward-voltage drop and fast recovery. You must use the two designated Schottky diodes for the output; otherwise, negative kickbacks from the driver transformer confuse the PWM IC's internal logic.

The current transformer's output feeds back to the IC's current-limiter input to provide current control. The IC's ramp input also receives the slope control signal from the emitter follower fed from pin 6 of the PWM IC. You must adjust the potentiometer until the switching waveform is clean at any load on the output.

The 2N4213 SCR and associated circuitry provide current limiting. When you first apply input voltage, C₁ charges until zener diode D₁ breaks down. D₁'s breaking down triggers the SCR, which in turn dumps the energy from C₁ into the PWM IC. If the supply begins running, the auxiliary winding on the output transformer will generate the supply current for the PWM IC, thus sustaining continuous operation. When the auxiliary voltage fully develops, Q₁ grounds the gate of the SCR, preventing any further firing. In case of a short on the output, the auxiliary voltage drops below the low-voltage shutdown threshold of the PWM IC (8V). All operation ceases and C₁ tries to turn on the PWM IC, which is possible only when the short clears.

EDN

Acknowledgment

The author wishes to thank Dave Cooper, John Estebrook, Gary Edwards, and Brian Pollard of Bell Northern Research for their valuable hints that helped in realizing the designs described in this article.

Author's biography

Stephen S Banfalvi is a member of the scientific staff for Bell Northern Research's Power Div in Ottawa, Ontario, Canada. Stephen has been with Bell Northern for four years doing research into high-frequency switching supplies. Previously he worked for Telsat Canada. He obtained a diploma of electrical engineering at the Technical State University of Budapest, Hungary, and has two patents. In his spare time he enjoys boating, skiing, and classical music.



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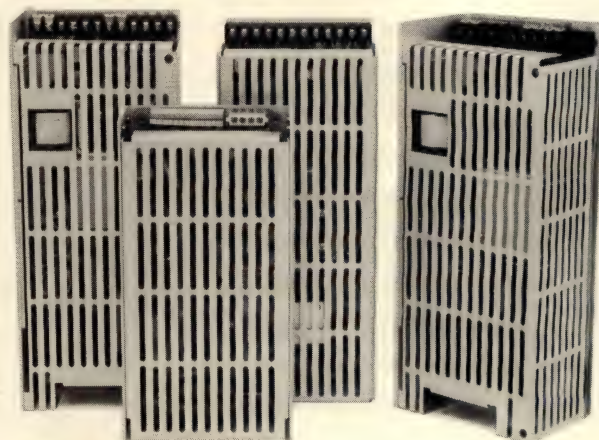
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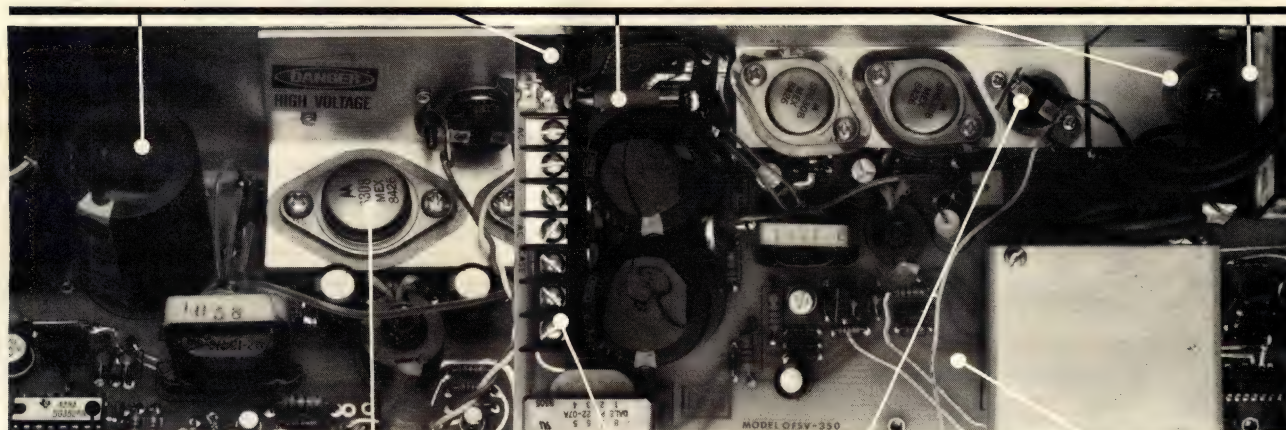
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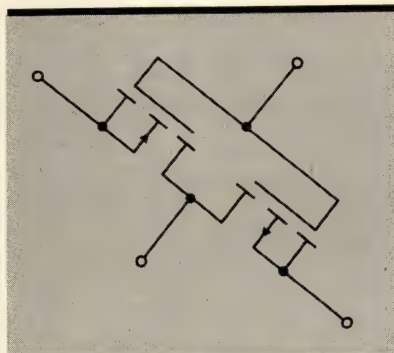
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CHAPTER 4

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To protect both their national security interests and TV reception, governments have established (or are establishing)

CHAPTER 3

CHAPTER 2

CHOMERICS

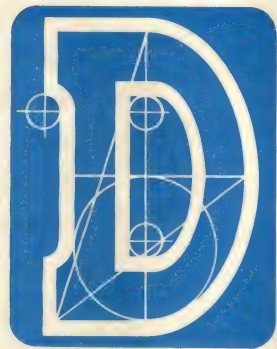
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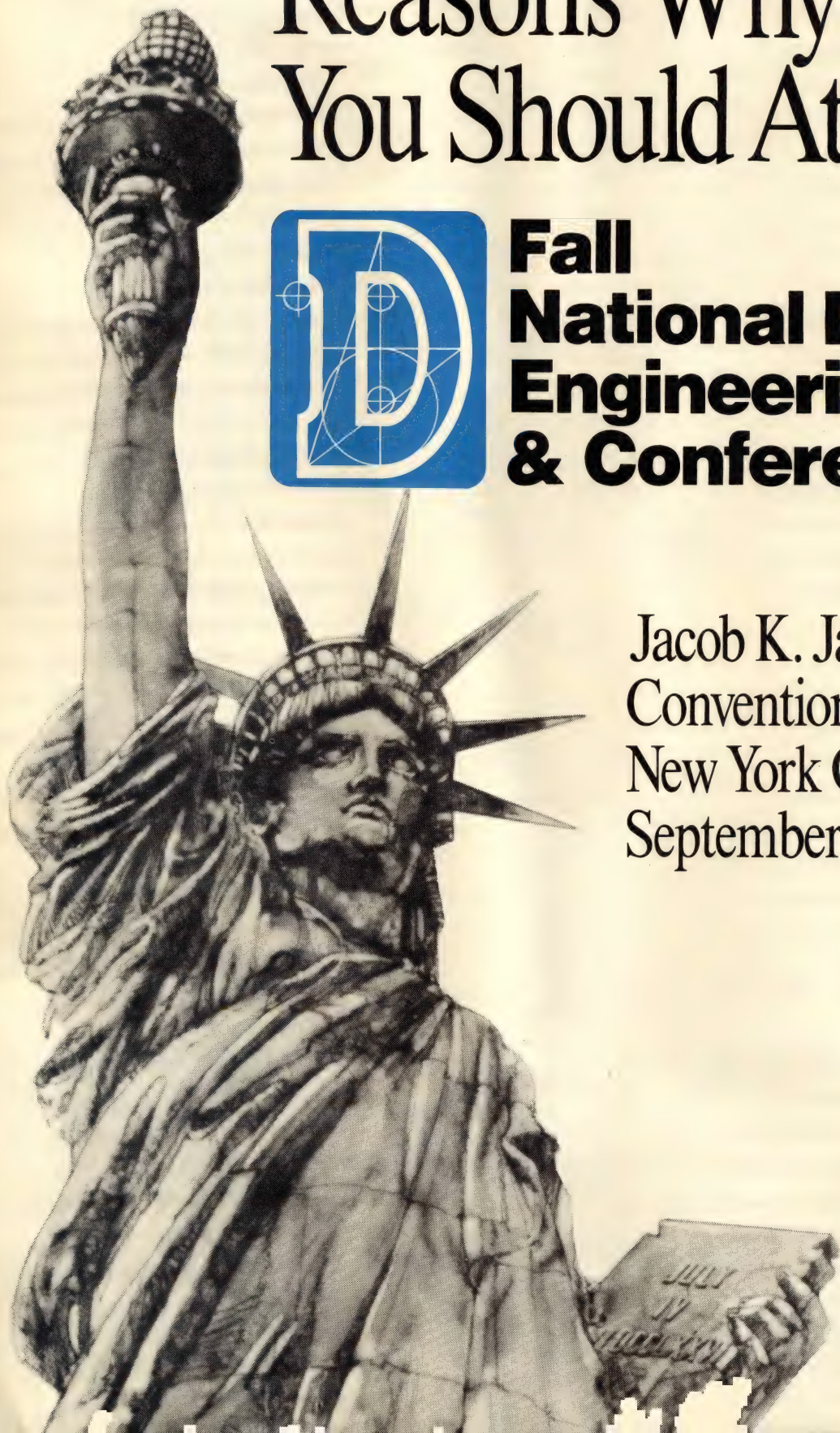
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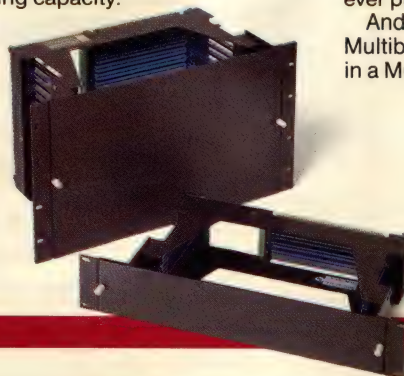
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CIRCLE NO 126

Analyzers aid in the design of closed-loop systems

You can use the various functions of a dynamic signal analyzer to derive the open-loop frequency response of a system from measurements taken at various points in the system. This article, Part 3 of a 3-part series, discusses how to use DSAs to develop and model a control system. Part 1 of the series presented an overview of classical linear control theory, and part 2 considered the role of DSAs in control-system measurement.

Steve Asbjornsen and Owen Brown,
Hewlett-Packard Co

By manipulating the classical graphical-analysis tools of linear control theory, a dynamic signal analyzer (DSA) can greatly assist you in designing and modeling stable closed-loop, negative-feedback control systems. You can use a DSA's internal waveform-math functions to calculate the frequency response of a closed-loop control system by measuring its open-loop frequency response (**Refs 1 and 2**). By analyzing a closed-loop system's open-loop response, you can tell whether the system is stable or unstable, and you can design compensation networks to stabilize an inherently unstable system.

DSAs allow you to use three separate techniques for measuring the open-loop frequency response of a closed-loop system: the loop-open direct method, the loop-closed direct method, and the loop-closed calculated method. In the loop-open direct method (**Fig 1**), which is defined by the expression $B(j\omega)/E(j\omega)$, you open the loop by removing the summing junction from the system. You then inject a stimulus signal at point $E(j\omega)$ and measure the response at point $B(j\omega)$.

The ratio $B(j\omega)/E(j\omega)$ provides the gain and phase characteristics of $GH(j\omega)$, the open-loop frequency response. This technique lets you determine the stability of the loop before you close it. Before taking this measurement, however, you must take steps to avoid four problems: overdriving the system, changing loading conditions, system saturation, and loss of operation.

Overdriving the system

When you stimulate a high-gain system, you must be careful not to overdrive the system, that is, to exceed any part of the system's maximum operating range (a situation that might arise, for example, when a sine-wave stimulus sweeps through a resonance). If you exceed this range, you could introduce nonlinearities into the measurement. Furthermore, if the stimulus contains high-energy components, you could damage the system.

Fortunately, you can often avoid overdrive by using a DSA's monitoring functions. The monitoring functions provide source-level control that can vary the stimulus level to maintain a specified input level to either channel of the analyzer.

You must pay attention to the system's loading conditions. To obtain a measured frequency response that's an accurate representation of $GH(j\omega)$, you must make sure the open-loop system is loaded with the same impedances during testing that will exist when the loop is closed.

You must also avoid system saturation, the condition in which the output at $B(j\omega)$ gets stuck at the maximum output level when you open the control loop. Such a condition is often caused by the reaction of extremely high loop gains to very small dc offsets—or to integrating components that naturally accumulate stray dc levels—in the absence of the countering effects of negative feedback. When system saturation occurs, you must abandon the loop-open direct technique.

Finally, you must avoid loss of operation (ie, system disruption to the point of failure), which can occur when you open the system's control loop. For example, consider a disk drive's read/write-head-positioning system

and the magnetic interface between the head and a prerecorded track on the disk platter. If you open the loop, you won't be able to maintain the interface so that it stays within normal operating conditions. If you stop the disk so that you can position the head over a track on the disk, the magnetic interface will disappear. If you rotate the disk, the slightest off-center condition will cause the head to skip across several tracks. Even the weakest stimulus signal will cause a similar effect. You simply can't test such a system with the loop open.

For a system that's suitable for loop-open direct testing, you should preferably use the DSA's FFT function with a nonperiodic stimulus signal. The FFT function works well because it yields good signal-to-noise performance and because, when you use a nonperiodic stimulus, the DSA allows you to average out distortion products. Further, the FFT function's speed can greatly reduce the total measurement time. When you use a nonperiodic stimulus to reduce the effects of system noise, you must use power-spectrum averaging.

The loop-closed direct method, which is defined by the transfer function $Y(j\omega)/Z(j\omega)$, uses the connection shown in Fig 2. The technique is a common one for

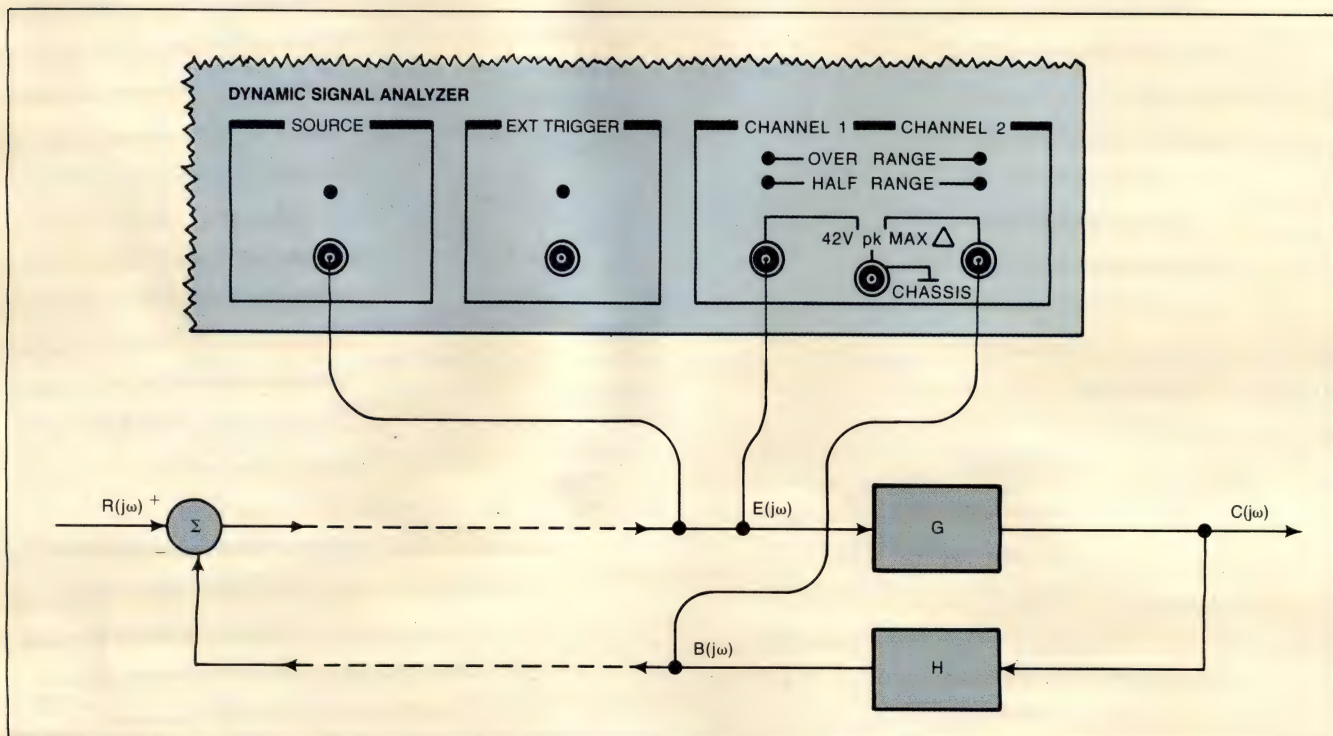


Fig 1—To take a loop-open direct measurement, you remove the summing junction from the closed-loop system. You then inject a stimulus signal at $E(j\omega)$ and record the system's response at $B(j\omega)$.

If a system's feedback summing junction is inaccessible, you can take response measurements by adding a summing junction at another point in the control loop.

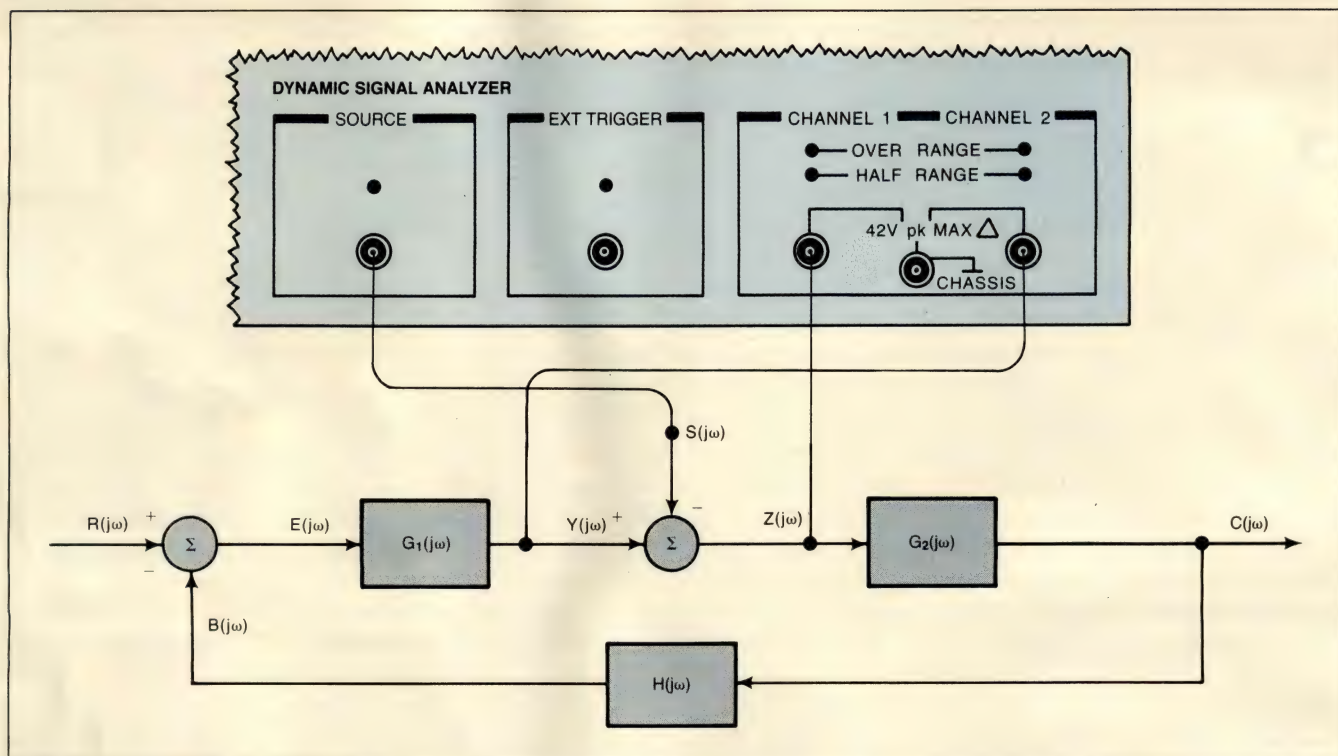


Fig 2—You can use the loop-closed direct measurement method only for systems that are stable in the closed-loop configuration. The technique is useful for negative-feedback systems that need periodic maintenance checks.

fore, you can use random noise) to reject system noise and provide the best linear estimate of a system's frequency response.

You can use random noise because the stray noise in the system appears in only one channel. If you average the relationship between the monitored signals, therefore, eventually the variation (caused by stray noise) in that relationship will drop to zero, as long as the stray noise is not phase-coherent with the stimulus.

The loop-closed calculated technique doesn't limit your selection of an analysis tool. You can use either SFA or FFT analysis with either time or spectrum averaging; for FFT analysis, you can thus use both periodic and nonperiodic stimuli.

The loop-closed calculated method differs from the loop-closed direct method mainly in that, in the loop-closed calculated method, the ratio $Y(j\omega)/S(j\omega)$ does not directly provide the open-loop frequency response, $G_1G_2H(j\omega)$. When you use the equation

$$Y(j\omega) = S(j\omega) \frac{G_1G_2H(j\omega)}{1 + G_1G_2H(j\omega)}$$

to solve for $Y(j\omega)/S(j\omega)$, and then declare the result to

be the quantity $T(j\omega)$, you obtain

$$Y(j\omega)/S(j\omega) = \frac{G_1G_2H(j\omega)}{1 + G_1G_2H(j\omega)} = T(j\omega)$$

If you solve for $G_1G_2H(j\omega)$ from this measurement, you obtain

$$G_1G_2H(j\omega) = \frac{T(j\omega)}{1 - T(j\omega)}$$

Using graphical techniques to perform these calculations would be impractical. DSAs' waveform-math functions, however, perform these calculations automatically. In fact, some of these instruments offer the $T(j\omega)/[1 - T(j\omega)]$ calculation as a single-keystroke operation.

The primary disadvantage of the loop-closed calculated technique is that, theoretically, it limits the maximum gain of the open-loop frequency response that you can calculate (from the $Y(j\omega)/S(j\omega)$ measurement) to the dynamic range of one channel of the analyzer. When you measure a signal with a sampling instrument, the instrument's dynamic range is directly

The measurement technique you choose to derive the open-loop response of your closed-loop system depends on the system's stability and nodal accessibility.

testing systems that can operate stably, though possibly at a reduced performance level, with the control loop closed. You can also use this technique to perform maintenance tests on established control systems, as well as to initiate testing of new systems.

When you test a new system, you should reduce its loop gain to a level that's low enough to ensure loop stability. If the tests verify the system design, you can increase the gain to standard operating levels and then retest the system. To perform the loop-closed direct test, you must monitor the signals that enter and exit any summing junction within the main signal path of the control loop. As long as you don't need to test the control loop in the presence of actual operating signals at the reference input, you can use the negative-feedback summing junction.

When you do need to test the control loop in the presence of actual operating signals at the reference input, or when the system's feedback summing junction is inaccessible (for example, when the head-to-disk magnetic interface of a disk drive is the system's feedback summing junction), you must add a summing junction at some other point in the control loop. Note the summing junction added between the two forward blocks, G_1 and G_2 , in the closed-loop system in **Fig 2**. (See **box**, "Create summing junctions.")

In the loop-closed direct method, you inject a stimulus signal into the loop at point $S(j\omega)$ and monitor the signals at points $Y(j\omega)$ and $Z(j\omega)$, the inputs and outputs of the summing junction. In this method, the signal at point $Z(j\omega)$ is the reference signal. Assuming that all the energy in the loop derives from the stimulus signal $S(j\omega)$, solving for the signals at $Y(j\omega)$ and $Z(j\omega)$ in terms of $S(j\omega)$ produces the expressions

$$Y(j\omega) = S(j\omega) \frac{G_1 G_2 H(j\omega)}{1 + G_1 G_2 H(j\omega)}$$

and

$$Z(j\omega) = S(j\omega) \frac{-1}{1 + G_1 G_2 H(j\omega)},$$

which is a reasonable assumption to make after you've used averaging to reduce noise. If you take the ratio of $Y(j\omega)/Z(j\omega)$, you obtain the equation

$$Y(j\omega)/Z(j\omega) = -G_1 G_2 H(j\omega),$$

which is the negative of the open-loop frequency response for the system. (The negation, the result of

including the negative feedback in the measurement, represents an additional 180° phase shift in the frequency response.) Some test instruments provide you with either waveform-math capabilities or a calibration constant to remove the additional phase shift.

The loop-closed direct technique is a practical one for measuring the frequency response of any system that can operate, at least minimally, when the loop is closed. In such systems, the loop-closed direct method avoids the problems of changing loading conditions, system saturation, and loss of operation that you encounter when you use the loop-open direct method.

Note, however, that when you use the loop-open direct method, you can't use power-spectrum averaging (the standard form of averaging of a DSA's FFT function) to reduce measurement noise. If you attempt to do so, you'll almost always get the wrong frequency-response measurement. Worse, increasing the number of power-spectrum averages will only reduce the variance of the erroneous result, so the measurement will appear to converge to a valid one.

You can't use power-spectrum averaging because any signals within the system not directly related to the stimulus signal (including system noise and any signals applied to the reference input) would pass through the summing junction unaltered. The signals would, therefore, appear in both channels and maintain constant gain and phase relationships (predictably 0 dB and 0°) from measurement to measurement, making it impossible to average them out. And unless you were to compare your measurement with a known-good measurement, you probably wouldn't notice the error.

In any case, a DSA's signal-processing function removes (from each channel) the nonstimulus-related signals in the loop before the DSA calculates the frequency response. The DSA can be operating either in its SFA (swept-frequency analysis) mode or its FFT mode (using time averaging and a periodic stimulus). If coherent distortion products exist in the nonstimulus-related signals, however, the SFA mode is generally the preferred one.

Loop-closed calculated measurement

The transfer function for the loop-closed calculated measurement technique (**Fig 3**) is $Y(j\omega)/S(j\omega)$. This method resembles the loop-closed direct method except that here the DSA uses the applied stimulus, instead of the signal at $Z(j\omega)$, as the reference signal. With the loop-closed calculated method, however, you can use an FFT's power-spectrum averaging mode (and, there-

Create summing junctions

To put an electronic summing junction into a control loop, you can use two basic approaches. You can either add new circuitry to the loop to realize the summing junction (**Fig A**), or you can use an existing buffer amplifier (**Fig B**). In the first approach, you can calculate the open-loop frequency response from the measured transfer functions $Y(j\omega)/Z(j\omega)$ and $Y(j\omega)/S(j\omega)$:

$$\frac{Y(j\omega)}{Z(j\omega)} = -G_1G_2H(j\omega);$$

$$\frac{Y(j\omega)}{S(j\omega)} = \frac{G_1G_2H(j\omega)}{1 + G_1G_2H(j\omega)} = T(j\omega).$$

Therefore,

$$G_1G_2H(j\omega) = \frac{T(j\omega)}{1 - T(j\omega)}.$$

When you're using an existing amplifier (**Fig B**) to make a $Y(j\omega)/S(j\omega)$ measurement, you must account for both the gain of the amplifier and the fact that polarities between the $Y(j\omega)$ and $S(j\omega)$ legs of the summing junction now match. The following equations account for these factors:

$$\frac{Y(j\omega)}{Z(j\omega)} = -G_1G_2H(j\omega);$$

$$\frac{Y(j\omega)}{S(j\omega)} = \frac{-G_1G_2H(j\omega)}{\frac{R_1}{R_2} + G_1G_2H(j\omega)} = T(j\omega);$$

$$G_1G_2H(j\omega) = \left(\frac{-T(j\omega)}{1 + T(j\omega)} \right) \left(\frac{R_1}{R_2} \right).$$

In all cases, the amplifiers used to implement the summing junction should have bandwidths much greater than the bandwidth of the control system, and they should also have flat frequency responses within the bandwidth of the system.

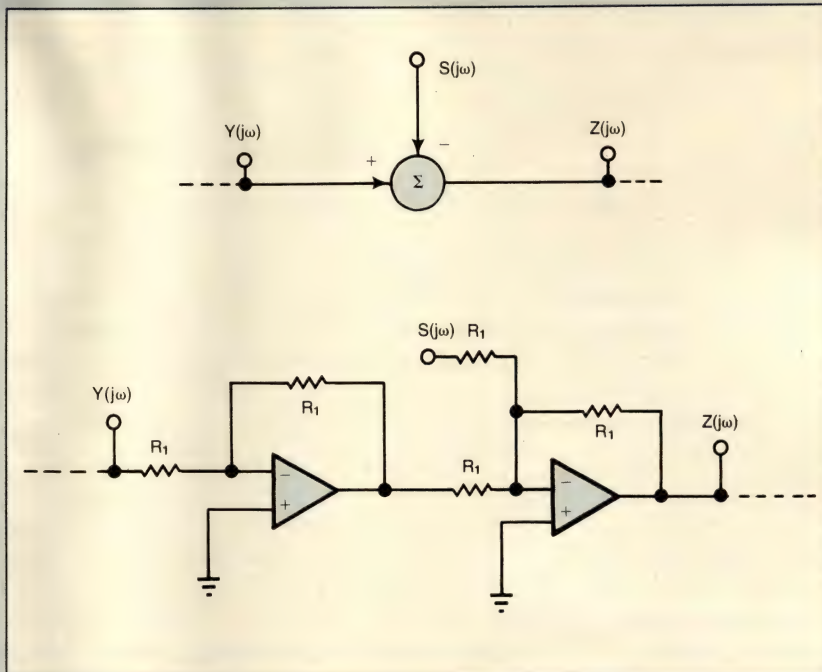


Fig A—This circuit, a typical configuration for adding a summing junction to a control system, allows you to use the measurements of $Y(j\omega)/Z(j\omega)$ and $Y(j\omega)/S(j\omega)$ in conjunction with a DSA to calculate the system's open-loop frequency response.

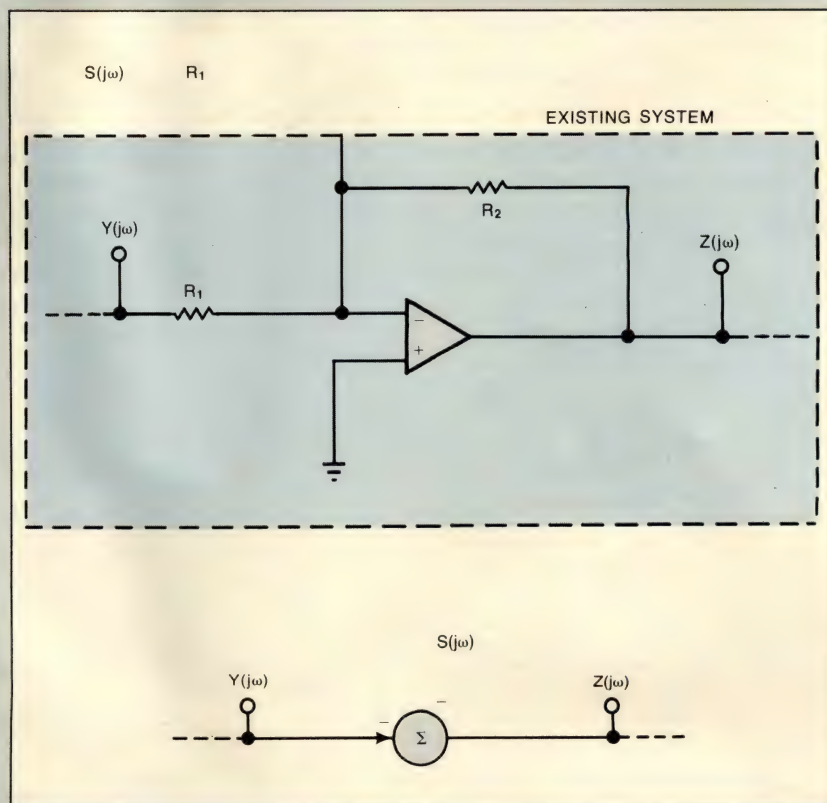


Fig B—You can take advantage of an existing amplifier in a control loop by simply connecting a resistor to the amplifier's summing junction. Using this technique, you take $Y(j\omega)/Z(j\omega)$ and $Y(j\omega)/S(j\omega)$ measurements and use the DSA's waveform-math function to calculate the system's open-loop frequency response.

Loop-closed direct testing is practical for systems that are stable in closed-loop connection, and it avoids the problems of loop-open direct testing.

related to the number of bits of the sampling A/D converter.

In practice, several factors prevent you from reaching even the theoretical limit. For example, if the noise power in the system is much larger than the power of the signal of interest, you must adjust the input sensitivity of the A/D converter to handle the noise. This reduced sensitivity leaves fewer bits of the A/D converter available for resolving the signal of interest.

Mismatch between the input channels of the analyzer can also severely limit the accuracy of the measurement. Unfortunately, the mentioned limitations will not create an obvious distortion of the calculated gain. They may simply produce an unexpected flat region of the open-loop gain in portions of the curve that have very high loop gains.

Design and modeling

Although you develop different control systems differently, you can separate most development into two categories: analytical design and design using frequency-response manipulation. Analytical design is useful for determining the performance of large, expensive

systems that must work the first time. In this method, you find the location of the specific poles and zeros of each system component and use frequency-response data and known properties of the system components to help identify those poles and zeros. Once you know the pole/zero locations, you can calculate the system's performance from the models.

Frequency-response manipulation is useful for improving the system's performance. In this technique, you must either alter the components so that their pole/zero locations change or add compensation networks to provide the poles and zeros necessary to generate the required performance. To use this pole/zero-manipulation process, you must work with mathematical representations of the system and obtain accurate models of the system and its components.

When you add compensation networks, however, you don't need to know the exact location and cause of each pole and zero. Instead, you characterize the system completely by its open- and closed-loop frequency responses. You add compensation networks whose frequency responses will constructively change the system's overall frequency response. In effect, this

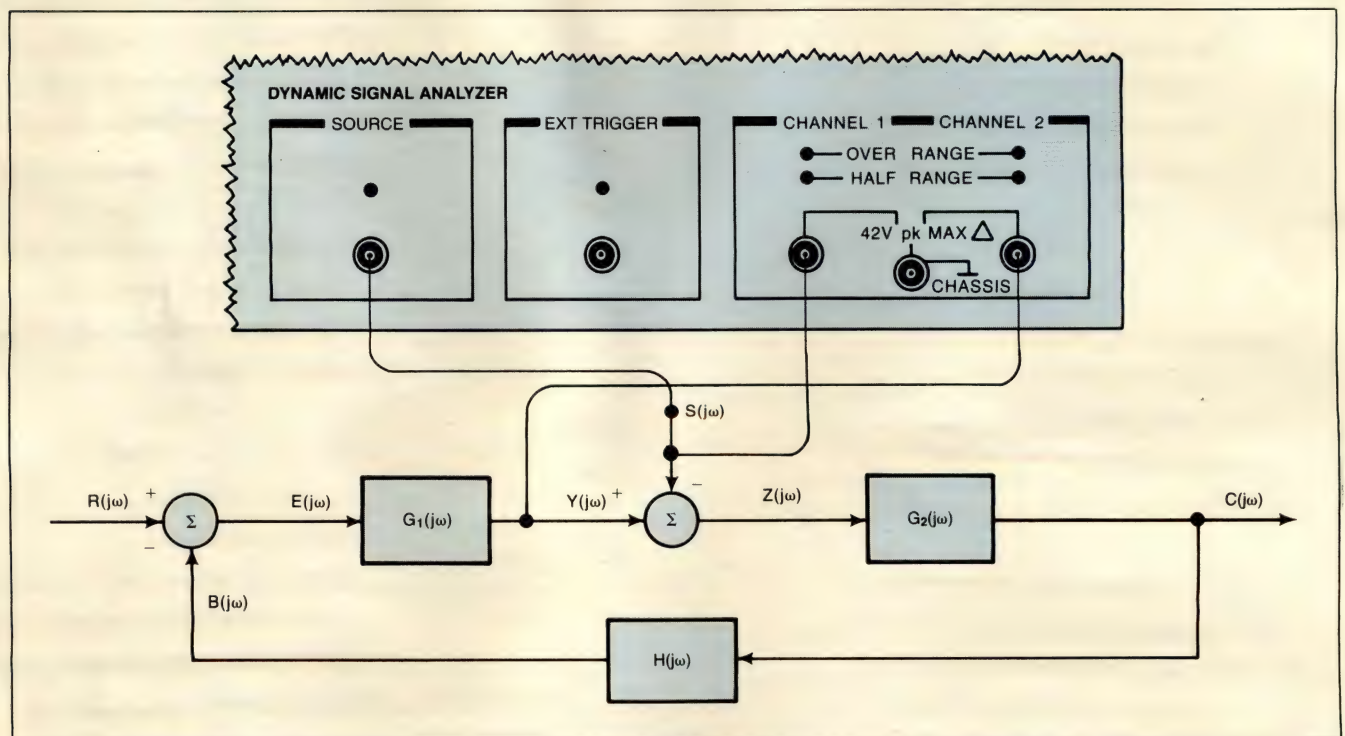


Fig 3—Loop-closed calculated measurement takes advantage of the FFT function's power-spectrum averaging mode. This mode of measurement, when used with a random-noise stimulus, provides the best possible linear estimate of a closed-loop system's frequency response. A DSA's waveform-math capability helps you interpret the results you obtain with this measurement method.

approach lets you quickly calculate both the frequency response of a compensation network and the network's effect on the system.

The analytical-design and frequency-response-manipulation techniques are similar; the first is simply more concerned with designing with accurate analytical models (typically because of the lack of actual hardware), and the second is more concerned with the measured response of a system.

Typically, you can generate models in two different ways. First, if you have complete knowledge of a device's physical characteristics—such as its mass, friction levels, resistance, and other parameters—you can

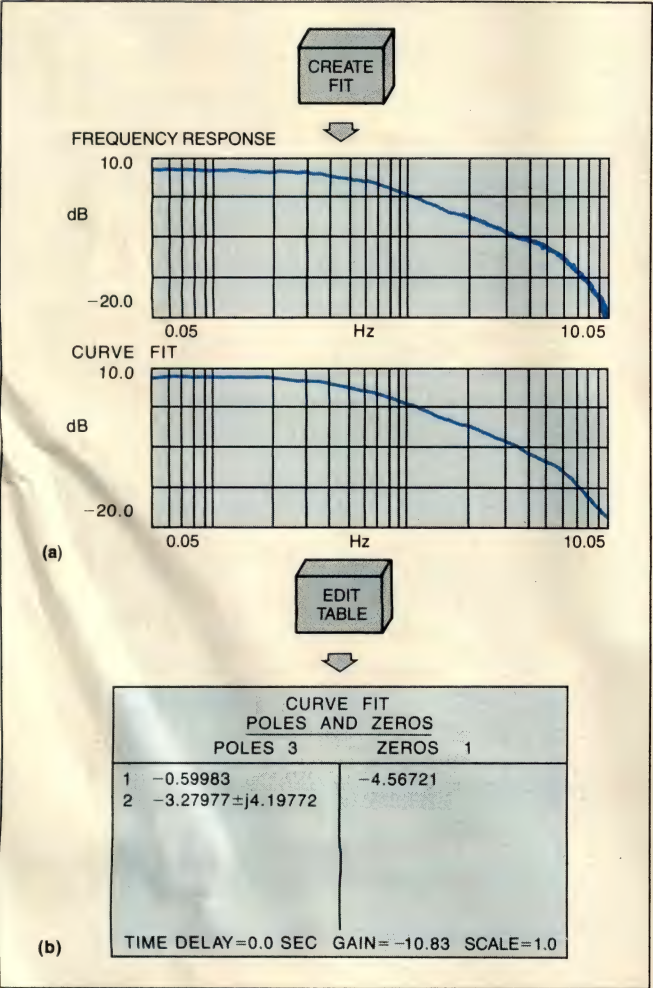


Fig 4—A DSA's curve fitter has an automatic weighting function, which allows the instrument to fit noisy data without producing inconsequential poles and zeros. The DSA displays the system's estimated frequency response below the measured data (a). The edit-table key makes the DSA produce the table of poles and zeros (b) used in the estimate.

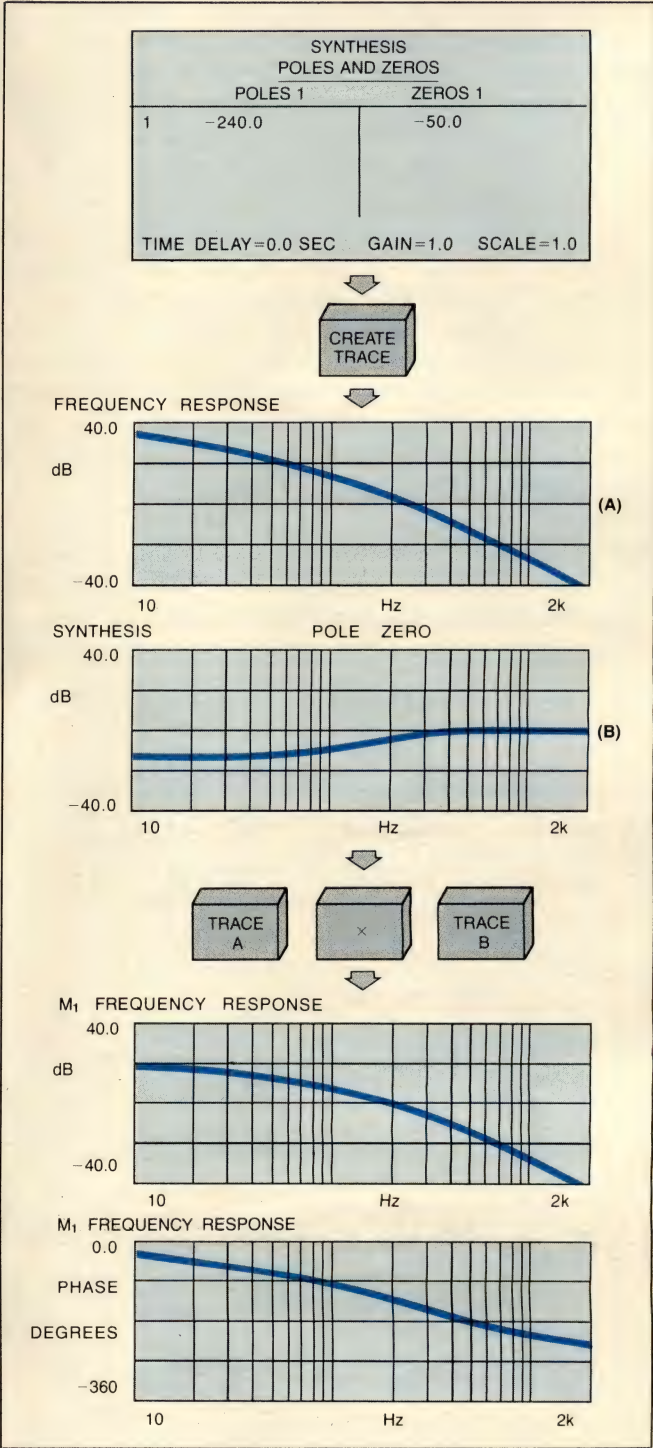


Fig 5—Based on the pole-zero data in a synthesis table, a DSA generates the compensation network's frequency response (trace B). Using waveform math, the DSA multiplies this response by the system's open-loop response (trace A); the results are the gain and phase plots for the compensated system.

In loop-closed calculated measurement, a DSA's FFT function provides a linear estimate of a system's response.

derive a model with them by using Lagrange's equations and other equations. If you don't know the device's physical characteristics, however, you can measure its frequency response and estimate the poles and zeros required to produce that response. When you're developing a system, you'll often have to use both of these techniques.

The most common technique for estimating the poles and zeros required to generate a particular frequency response is to examine a frequency response plotted on a Bode diagram (Ref 1) and determine the Q of resonances, the slope at which the system's gain rolls off, and the amount of phase shift through the system in relation to the gain slope. Once you master the technique, you can derive an estimate of the mathematical model for a simple system at a glance.

Using these techniques to estimate the model of a complex system, however, is not easy. For systems with many dominant complex poles, the task of analyzing gain and phase relationships is tedious and cumbersome, and it may result in inaccuracy, because you can't

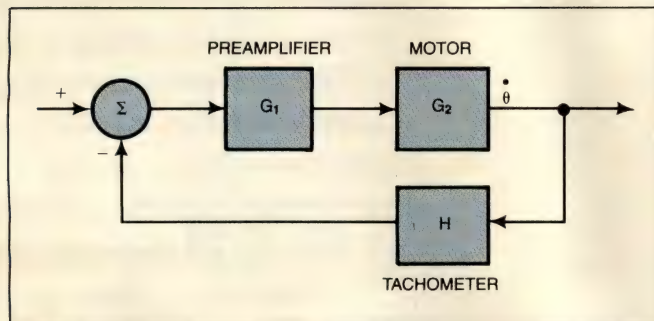


Fig 6—This simple motor-speed controller has all the elements of a negative-feedback, closed-loop system. The system provides an example of how you can exploit a DSA's frequency-response synthesis and waveform-math functions.

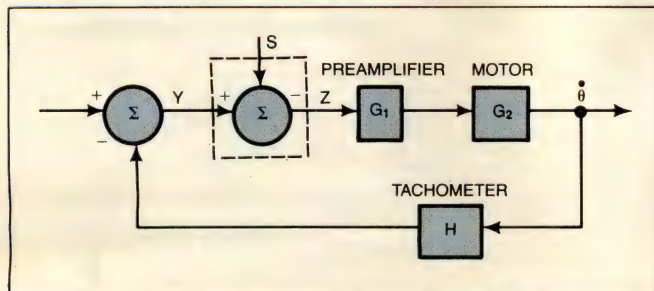


Fig 7—To perform operational testing at reduced gain for the normally unstable speed-control system, you add a summing junction at a point in the system before the preamplifier. This test uses the loop-closed calculated technique (Fig 3) to obtain a Y/S transfer function.

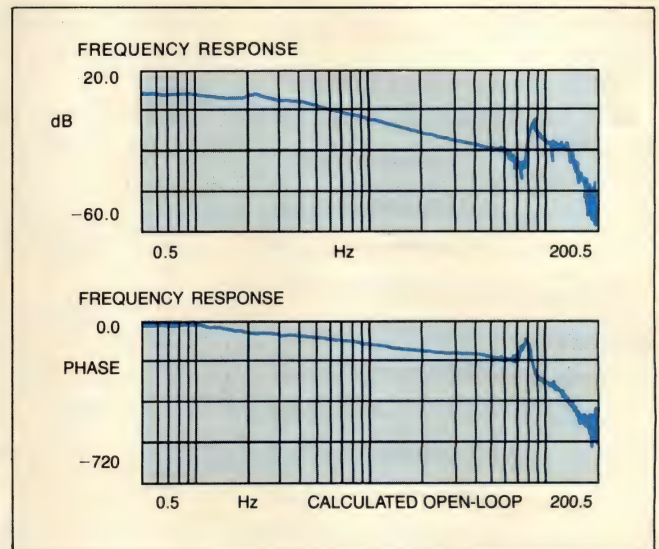


Fig 8—A sharp resonance at 90 Hz is evident in this open-loop frequency response obtained from Fig 7's Y/S measurement. The resonance stems from an excessively long drive shaft between the motor and its load.

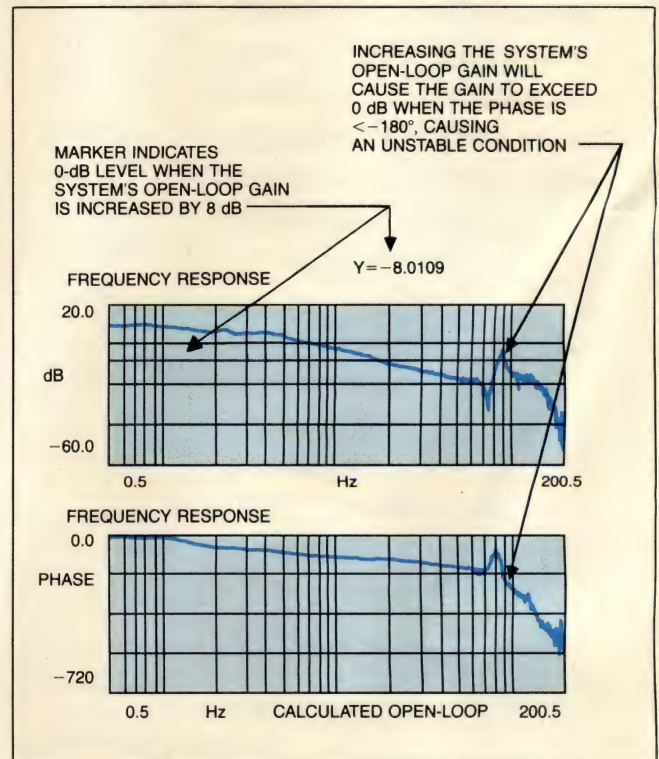


Fig 9—When you use the DSA's Y-axis marker to show the system's 0-dB level during normal operation, you can see that the resonance causes the system to become unstable when gain is adjusted to the desired level. For stability, the system's gain must not exceed 0 dB when phase is more negative than -180° .

easily sort out the overlapping gain/phase relationships of the many poles and zeros.

Historically, computer programs called curve fitters could automatically analyze a frequency response and produce a pole/zero model. These curve fitters, however, could not distinguish between good data and bad, or noisy, data. If the data was bad, you either had to alter it to remove noise before transferring the data to the computer, or you had to wade through a great deal of inconsequential pole/zero data, which the curve fitter generated to fit the noisy portion of the curve. The computer programs were, therefore, of limited value to designers.

Algorithms called weighting functions improved the usefulness of curve fitters by allowing the computer to analyze the quality of the data before attempting to fit it. Because of these weighting functions, modern curve fitters can successfully process the noisy frequency-response data associated with most control-system measurements, so they can quickly and accurately produce an estimate of a system's pole/zero model.

DSAs contain state-of-the-art curve fitters that are capable of using as many as 40 poles and 40 zeros to estimate the pole/zero model of a frequency response. In a DSA, you can call up the curve fitter with only two keystrokes. When the curve fit is done, the DSA

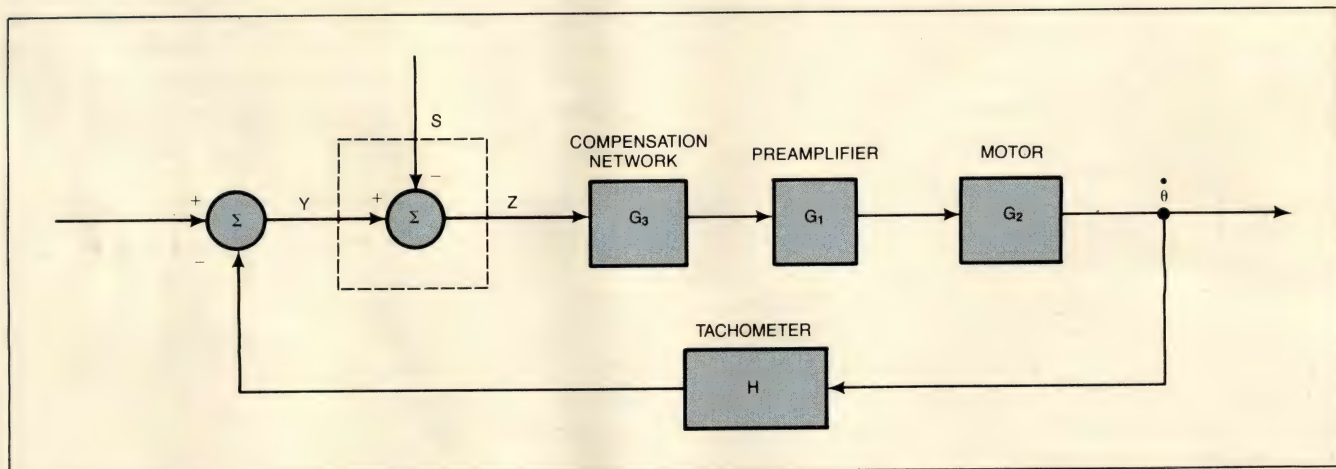


Fig 10—A lowpass filter counteracts the resonance arising from the motor's long drive shaft. Without the filter, the 90-Hz resonance causes instability when the system operates at its normal gain setting.

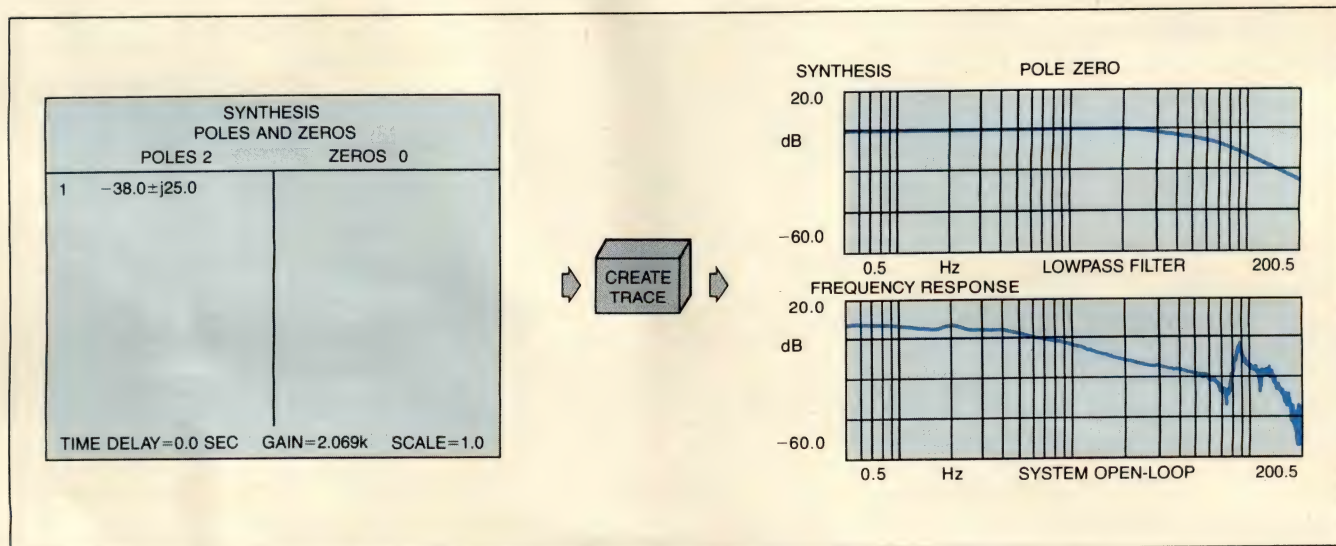


Fig 11—The DSA's frequency-response-synthesis function uses pole-zero data and waveform math to create the lowpass filter's response curve, which is displayed above the speed-control system's frequency response.

A DSA simplifies the task of determining the proper compensation network needed to stabilize closed-loop control systems.

calculates a frequency response from the model and displays that frequency response below the measured frequency response for comparison (**Fig 4a**). Another keystroke displays the table of poles, zeros, and gain (**Fig 4b**) that the curve fit produces.

After you estimate the model of a system or a compensation network, you must calculate the model's frequency response. If you do this calculation manually, you should use Bode's graphical techniques. If you use a DSA, however, you can obtain a higher degree of accuracy for both simple and complex systems.

A DSA's frequency-response-synthesis program performs the inverse function of an advanced dedicated curve fitter, allowing you to enter transfer functions that have as many as 40 poles and 40 zeros into the analyzer. The DSA then calculates and displays the frequency response. The programs also allow you to enter gain and delay parameters.

The frequency-response-synthesis function lets you immediately assess the effect a cascade compensation network will have on your system. By displaying the measured frequency response of a system on one trace and the synthesized frequency response of a compensation network on another, the DSA lets you make either a quick visual evaluation or a precise calculation of the combined frequency response of the two (**Fig 5**). (To make a precise calculation of the responses, you multi-

ply the two frequency responses using the DSA's waveform-math function).

Because curve fitters generate only linear models, the result of the curve fit will be a linear approximation of the device's operation. Should a nonlinearity (other than random noise) produce a large number of poles and zeros, you can reduce the order of the model by simply transferring the curve-fit data to the DSA's frequency-response-synthesis function and selectively subtracting or adding poles and zeros to obtain the best model (with the fewest poles and zeros).

You can then quickly assess the effects of your modifications by synthesizing the frequency response of the new model and comparing it with the measured response. The initial estimate provided by the curve fitter and the modifications handled by the frequency-response-synthesis function greatly reduce the time required to produce an adequate linear representation.

A case study

The system in **Fig 6** provides an example of how you can use frequency-response synthesis and waveform math to develop a relatively simple motor-speed controller. We constructed a prototype of the system and found, upon power-up, that the motor's speed was unstable.

Reducing the gain of the preamplifier by 8 dB stabi-

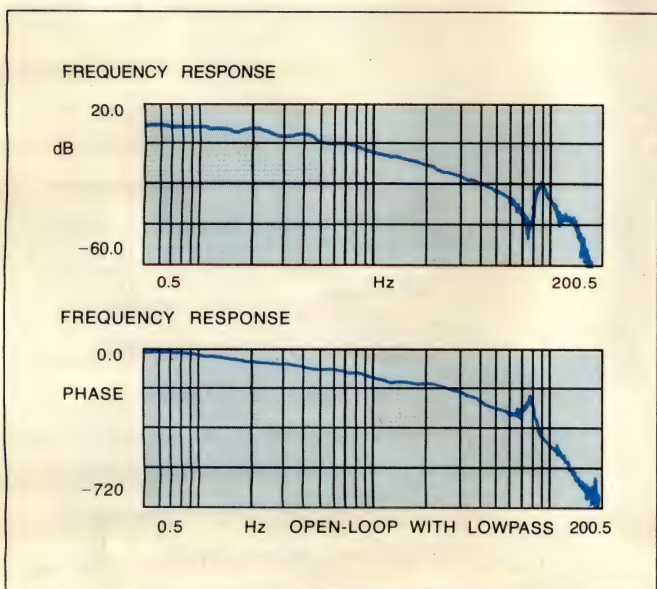


Fig 12—To obtain these curves, which are products of the responses of the system and the lowpass filter, you use the DSA's waveform-math function to perform the multiplication. The curves indicate that the use of the filter stabilizes the speed-control system.

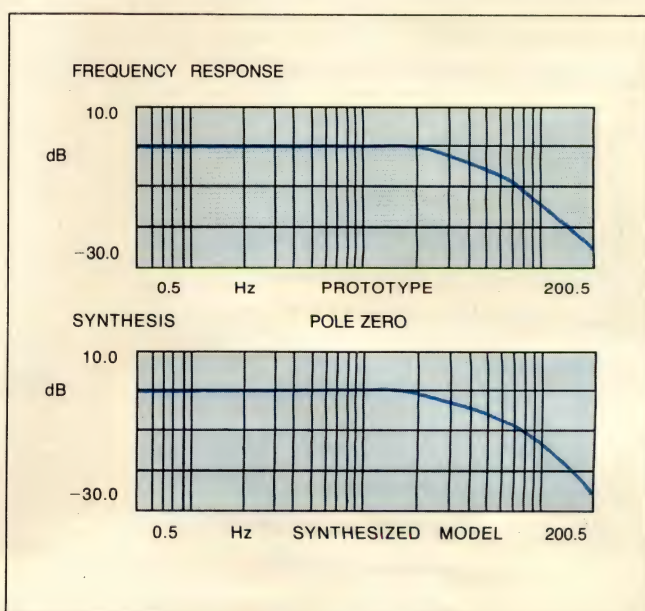
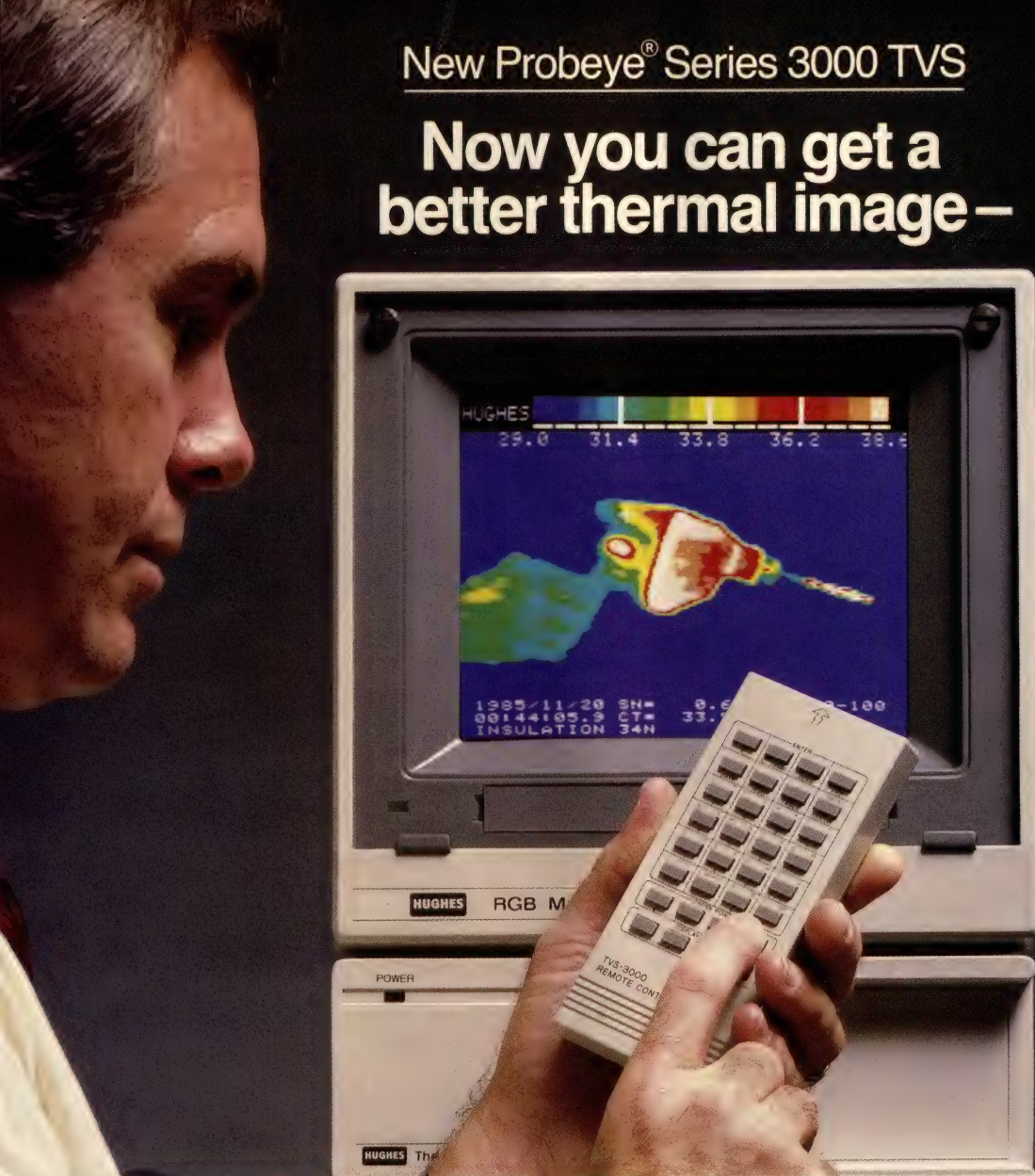


Fig 13—To check the design of the lowpass filter, you can compare the filter's measured (upper trace) and theoretical (lower trace) frequency responses.

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The curve-fitter function in a DSA automatically analyzes a system's frequency response and produces a pole/zero plot.

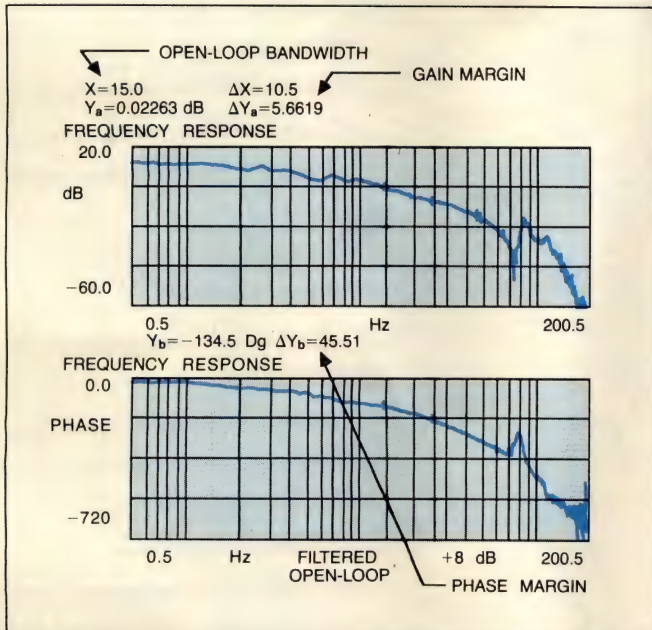


Fig 14—The frequency response of the compensated speed-control system shows that the lowpass-filter compensation network completely stabilizes the system. The DSA gives direct readouts of gain margin and phase margin.

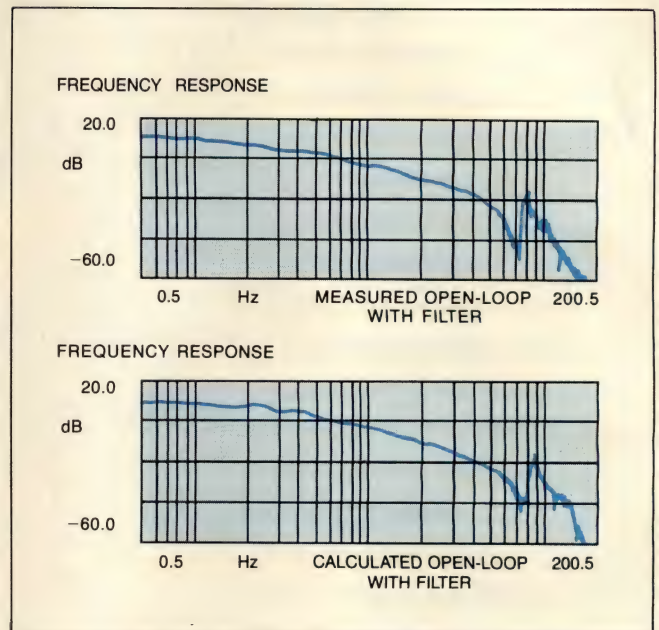


Fig 15—A final check on the speed-control system shows that the system's measured frequency response (upper trace) closely matches the response predicted (lower trace) by the DSA's frequency-response synthesis and waveform-math function.

lized the system, but degraded its performance below acceptable levels. While the system was at the reduced-gain level, we measured the open-loop frequency response by adding a summing junction to the system just before the preamplifier (Fig 7) and by using the loop-closed calculated (Y/S) measurement technique. Fig 8 shows the open-loop frequency response calculated from the Y/S measurement.

The measurement revealed a sharp resonance at approximately 90 Hz. When we placed the Y-axis marker at -8 dB to indicate the unity-gain (0-dB) location during normal system operation (Fig 9), we saw that the resonance did indeed cause the system to become unstable when gain was adjusted to the desired level.

The source of the resonance was a relatively long drive shaft attached between the motor and the anticipated system load. Redesigning the system would be too expensive, so we decided not to alter the drive shaft, but to find an electronic solution.

Because the problem was occurring at a relatively high frequency, we added compensation to the system in the form of a lowpass filter (Fig 10). Using the DSA's frequency-response-synthesis function, we entered the pole locations for a simple lowpass filter into the analyzer and synthesized and displayed the frequency re-

sponse above the system's measured frequency response (Fig 11).

By using its waveform-math function to multiply the two frequency responses, the DSA predicted the effect of adding the lowpass filter to the system's loop. Fig 12 shows the gain and phase of the modified system. The predicted response of the modified system indicated that the lowpass filter would be a good solution to the resonance problem, so we constructed a prototype of the filter.

To ensure that the design was correct, we measured and compared the frequency response of the filter prototype to its synthesized frequency response (Fig 13). Once we had confirmed its design, we added the filter to the system and increased the preamplifier's gain by 8 dB to its previous level. The system remained stable, but we measured the open-loop frequency response again to make sure that the gain and phase margins were sufficient to maintain stability.

The measurement indicated that the resonance had indeed been attenuated far below any level of concern and, using the analyzer's markers, we quickly recorded the gain margin, phase margin, and open-loop bandwidth (Fig 14). To evaluate the integrity of the design approach, we compared the measured open-loop frequency response of the modified system with the pre-

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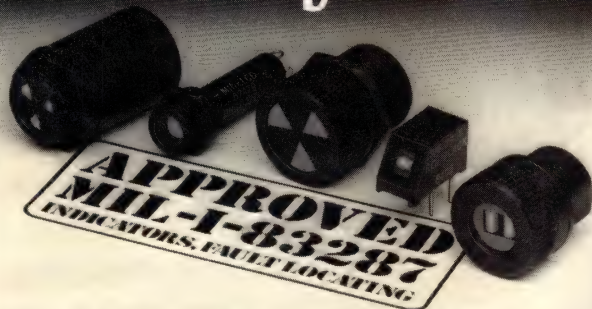
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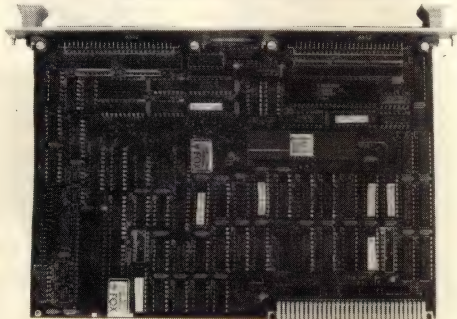
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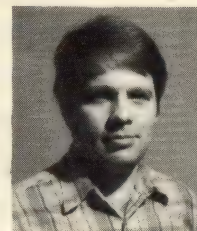
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2. Asbjornsen, Steve, and Brown, Owen, "Dynamic signal analyzers simplify measurement of linear control systems," *EDN*, April 17, 1986, pg 219.

Authors' biographies

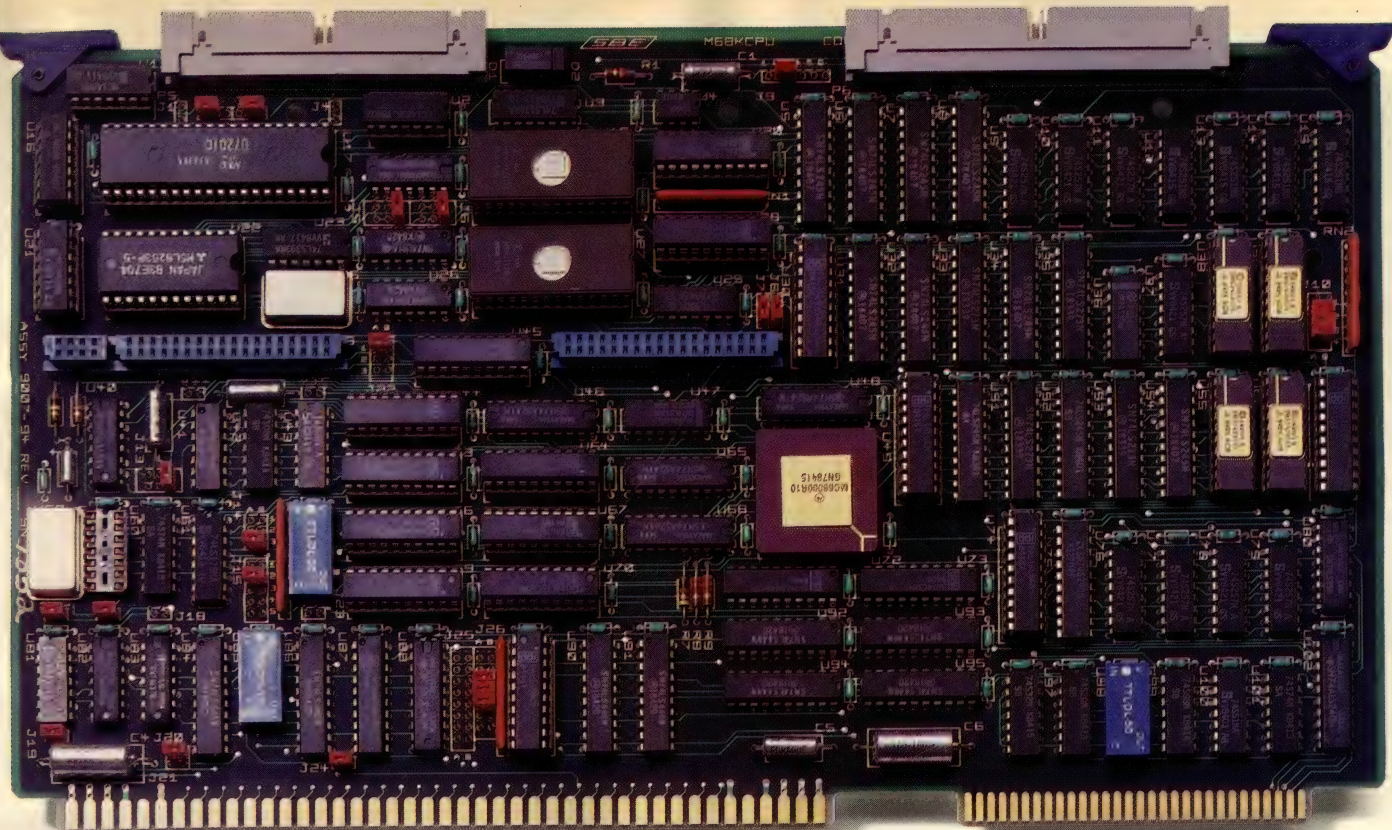
Steven W S Asbjornsen is a product-marketing engineer at Hewlett-Packard (Everett, WA), where he's responsible for control-system application and market development. He received a BSEE from the University of Washington and has been with HP for five years. Steve, who is a musician in his spare time, also enjoys hiking and waterskiing.



Owen Brown, who is in charge of product publicity for Hewlett-Packard (Palo Alto, CA), has worked for HP for two years. He has a bachelor's degree from Yale University and an MBA from the University of Chicago. His spare-time pursuits include painting and aikido.



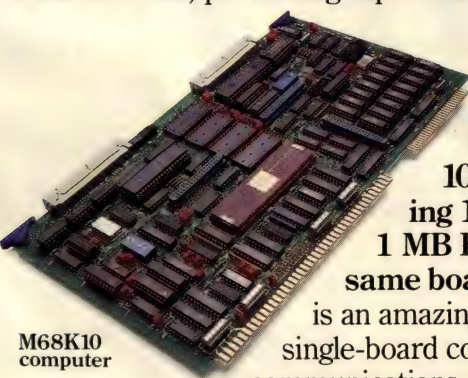
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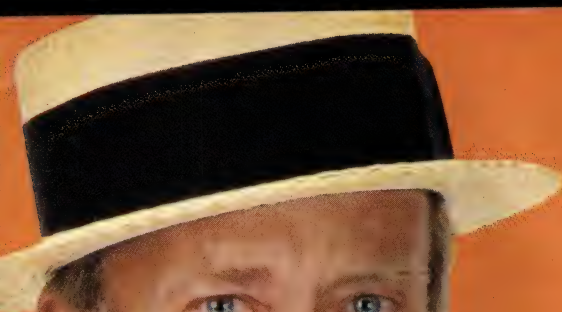
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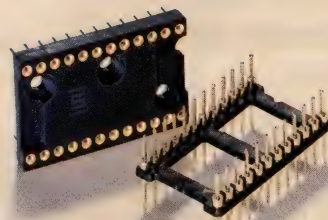


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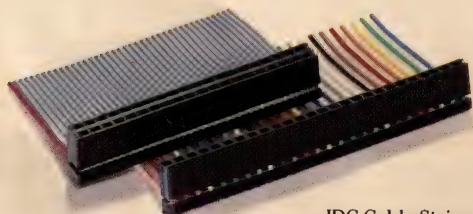


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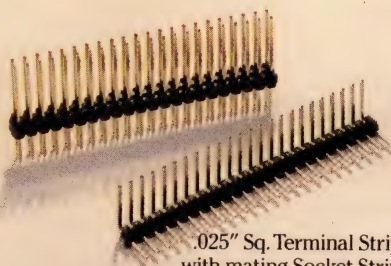
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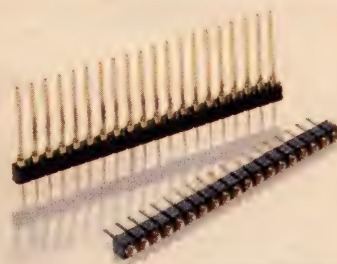
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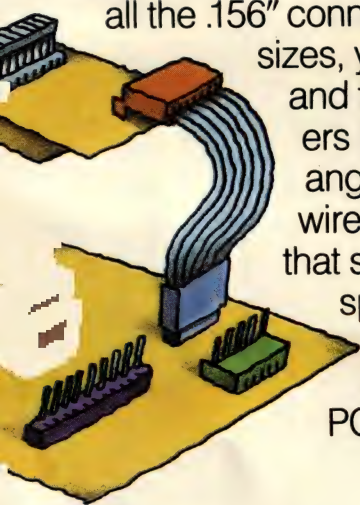
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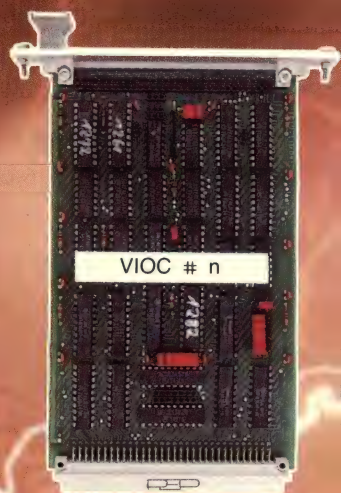
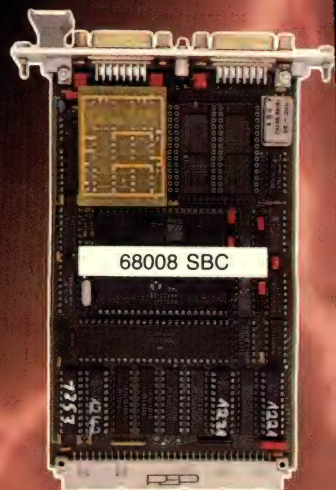
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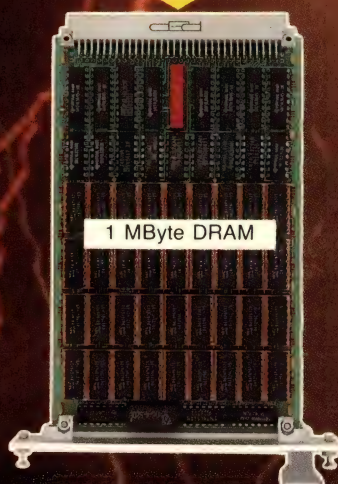
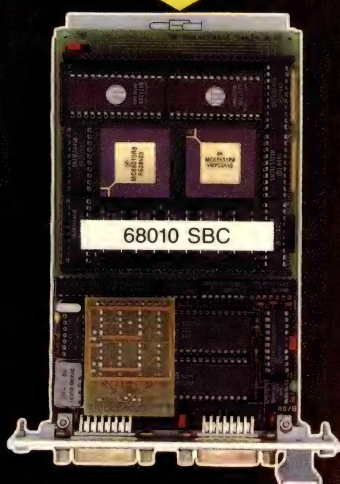
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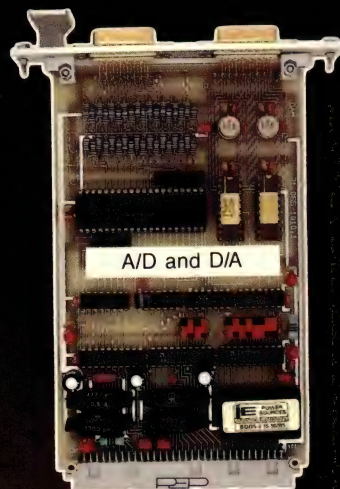
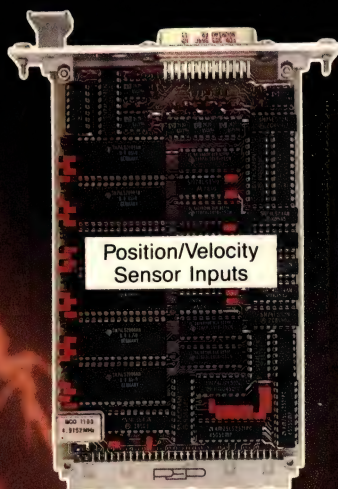
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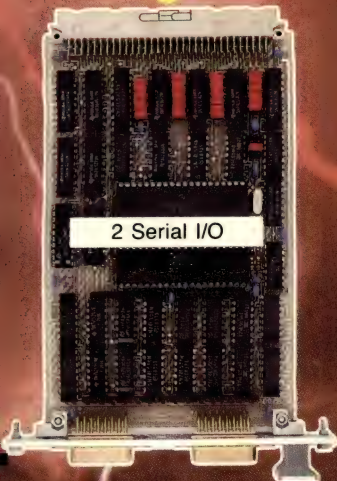
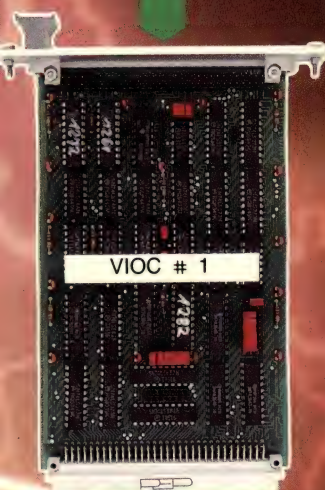


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DESIGN IDEAS

EDITED BY TARLTON FLEMING

IF chip forms audio decibel-level detector

Robert J Zavrel
Signetics Inc, Sunnyvale, CA

The NE604 is a low-power IF chip that includes a logarithmic signal-strength output. Fig 1's circuit draws less than 5 mA from a 6V supply and offers a signal sensitivity of $10.5 \mu\text{V}$. Although the chip is intended for cellular-radio and other RF applications, the log output provides an 80-dB range of response and $\pm 1.5\text{-dB}$ accuracy in the 100-Hz to 10-kHz audio range (Fig 2).

You capacitively couple the audio signal to pin 16. The log circuit generates approximately $10 \mu\text{A}$ per 20 dB of input signal at pin 5; you convert this current to voltage by connecting $100 \text{ k}\Omega$ (R_2) from pin 5 to ground. You can then measure this voltage directly with a voltmeter, or buffer and filter the voltage as shown using op amps $\text{IC}_{2\text{A}}$ and $\text{IC}_{2\text{B}}$. A standard 0 to 5V meter with a linear decibel scale serves to display 80 dB of signal level. To measure higher audio levels, add a resistive attenuator at the chip's audio input.

R_1 and C_1 form a lowpass filter. Specifying $2 \text{ k}\Omega$ for R_1 provides maximum linearity; you should adjust C_1 to change the filter's cutoff frequency. A higher value for C_1 lowers the circuit's output to about 0.6V when no audio signal is present (Fig 2). Lowering C_1 increases the frequency response, but raises the circuit's output

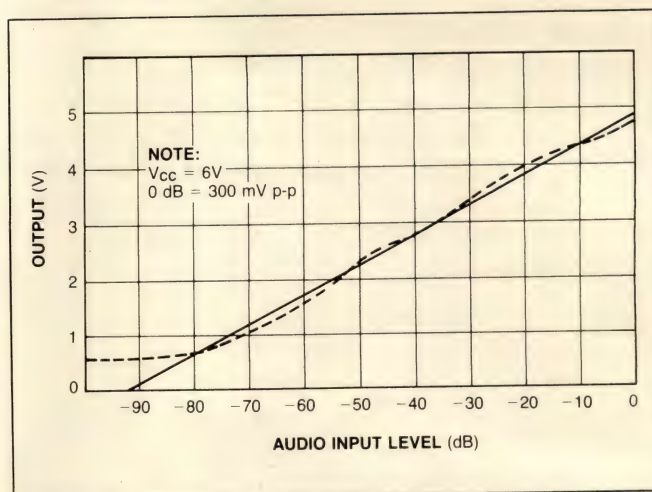


Fig 2—The dotted line indicates the response of Fig 1's circuit for the 100-Hz to 10-kHz audio range; the solid line indicates an ideal response. Full scale (0 dB) equals 300 mV p-p.

when no audio signal is present. The filter R_3/C_3 provides a tradeoff between meter damping and ripple attenuation. If both a quick response and low ripple are required, you must substitute a more complex, active lowpass filter. **EDN**

To Vote For This Design, Circle No 746

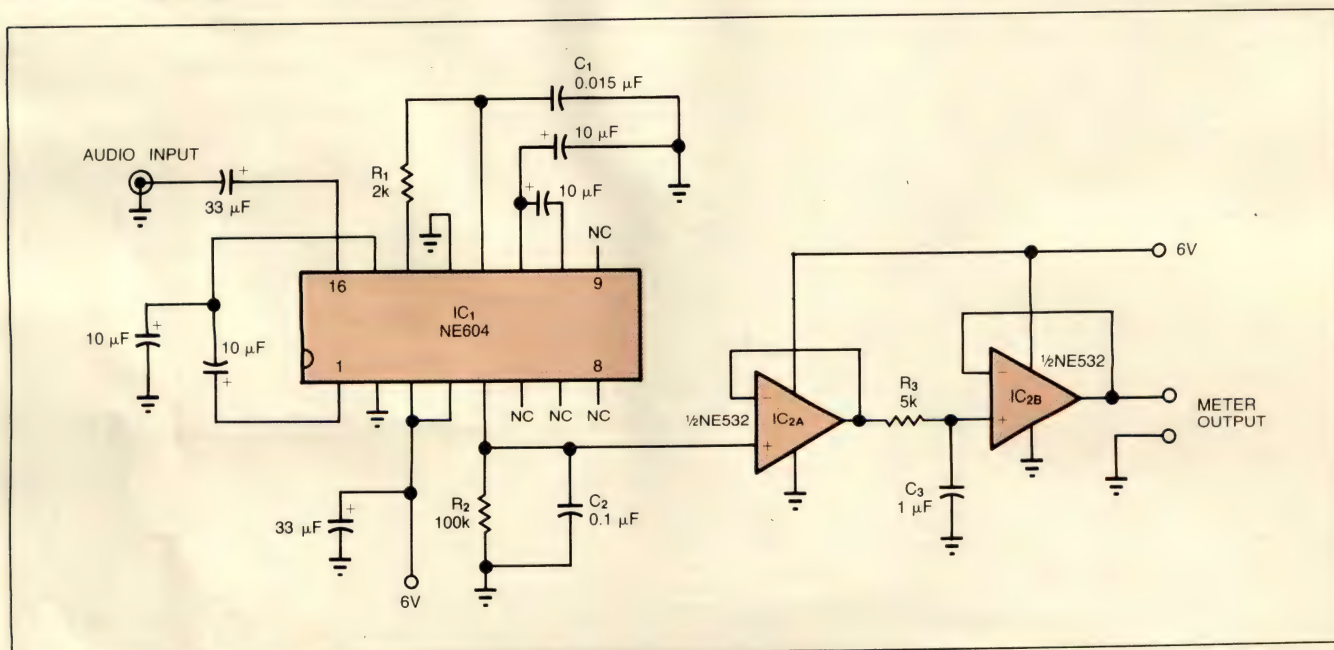


Fig 1—You can measure audio signal levels to $\pm 1.5\text{-dB}$ accuracy using a dual op amp and an FM IF chip (normally used for cellular-radio and other RF applications). Sensitivity is $10.5 \mu\text{V}$; power consumption is 30 mW.

Adjustable Schmitt trigger uses one IC

Gregg A Butler
Analog Devices, Wilmington, MA

You can use a balanced modulator/demodulator circuit, IC₁ (Fig 1), to build a precision Schmitt trigger with independently adjustable offset and hysteresis. You determine these parameters by providing the voltages V_H and V_R :

$$\text{hysteresis} = V_H = V_{T1} - V_{T2}$$

$$\text{offset} = V_R = V_{T1} + V_{T2}$$

(V_H must be equal to or greater than 0 to maintain positive feedback on the comparator during transitions; V_R can be either polarity.) Fig 2 illustrates the system's transfer function.

In Fig 1, the IC includes two amplifier channels plus a comparator that selects between the two. The external connections and internal application resistors configure the channel A amplifier as a voltage follower and the channel B amplifier as a unity-gain inverter. External connections apply V_H to channel B (via pins 16 and 15) as well as to channel A.

Thus, the comparator determines the polarity of V_O . V_O in turn, affects the comparator's noninverting input voltage V_T , which equals the average of V_O and V_R . Two

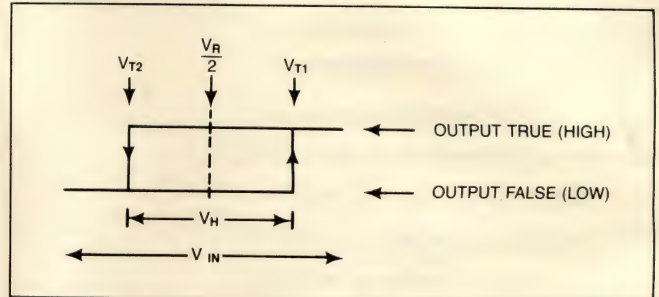


Fig 2—The system's transfer function shows the relation of the output and V_{IN} .

distinct trigger levels are created as V_O switches its polarity:

$$V_{T1} = V_R/2 + V_H/2$$

$$V_{T2} = V_R/2 - V_H/2$$

You apply V_{IN} to the comparator's other input (pin 9), and obtain an open-collector output at pin 7. When low, the output remains low until V_{IN} exceeds V_{T1} . When high, the output remains high until V_{IN} drops below V_{T2} .

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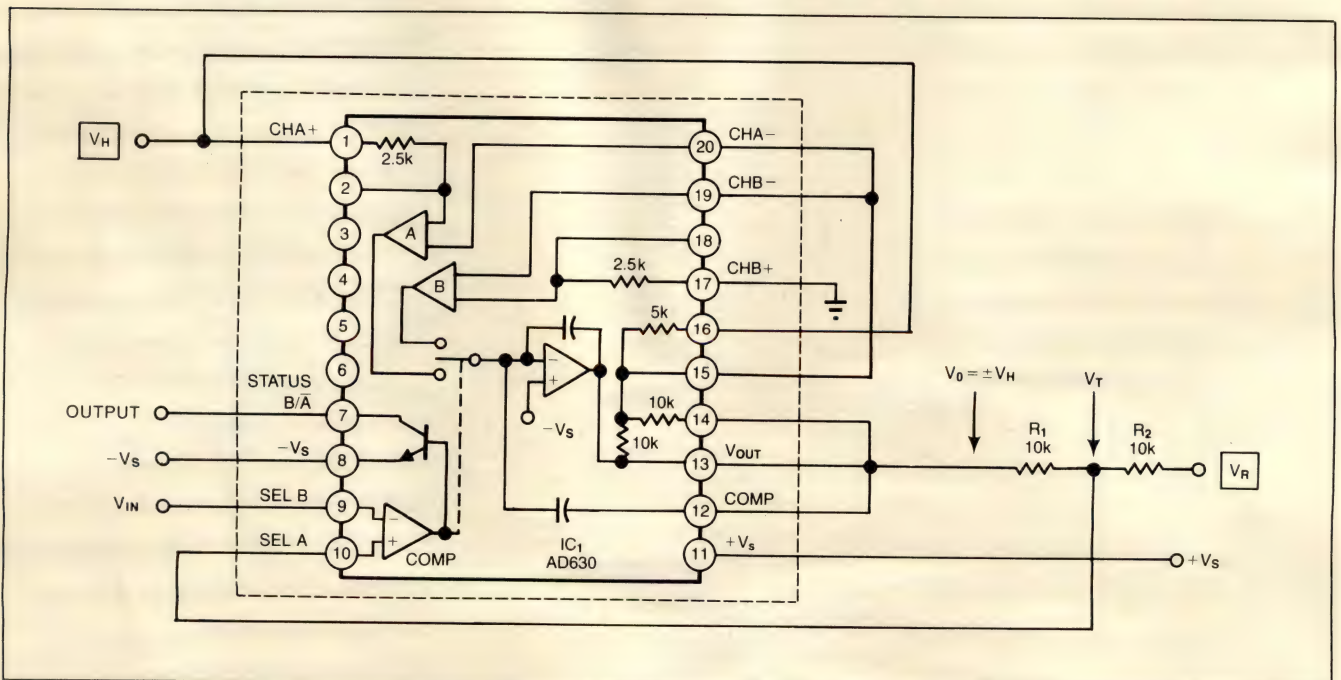
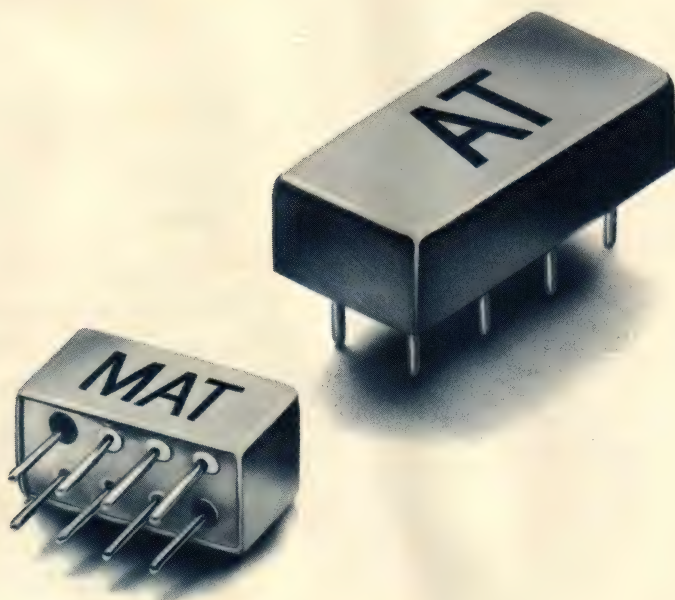


Fig 1—A balanced modulator/demodulator IC provides a Schmitt-trigger output. You set the hysteresis by adjusting V_H , and you set the offset by adjusting V_R .

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Circuit gates data channels

Al Rizzotti

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The gating circuit in Fig 1 connects one of three data channels to a decoder on a first-come, first-served basis. Even though each channel is quiet most of the time, data arrives at random intervals, and sometimes two or more channels are active at once. Thus, to preserve the data's integrity, you can't simply connect the channels via an OR gate.

IC_{1A}, IC_{1B}, and IC_{2A} are monostable multivibrators (one-shots) that retrigger on a rising edge at their A inputs. Each trigger produces a single pulse of duration T_B, set by the components R and C. When no channel data is present, the IC₃ gates enable each channel input

(IC₄). For example, the first leading edge appearing at the input to IC_{4C} triggers IC_{2A}, whose output pulse causes the NOR gates IC_{3A} and IC_{3B} to disable the other two channels while data on channel 3 passes through to the output.

Data on any channel consists of a series of T_B-sec bursts. Each burst retriggers its corresponding one-shot, thus ensuring continued access to the decoder for that channel for as long as the transmission lasts (T_A sec). Then, all channels are activated and can await the next transmission. You may expand the circuit to include more channels.

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To Vote For This Design, Circle No 749

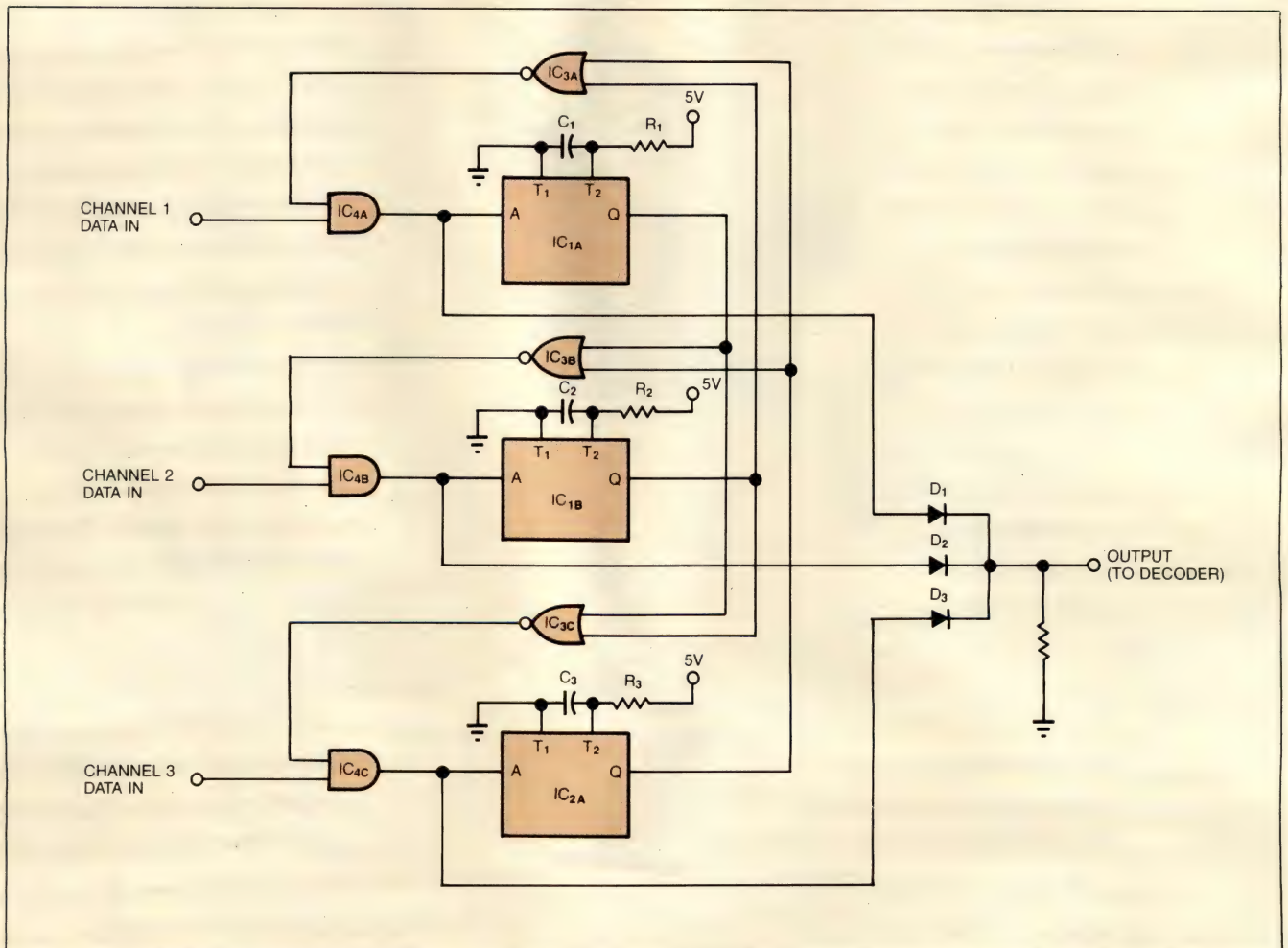


Fig 1—This gating circuit routes one of three data channels to the decoder while locking out the other two. Priority is on a first-come, first-served basis.

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Reduce noise in a serial bit stream

Stephen Strom
National Semiconductor, Mesa, AZ

As an FSK receiver's input signal shifts between two frequencies, the receiver's output switches between two logic levels, producing a serial stream of pulses. The pulse stream normally goes to a UART or similar device, which samples the data once in the middle of each bit interval; however, a noisy input signal can create spurious output pulses that appear as invalid data to the UART. You can detect faulty data using parity or CRC (cyclic redundancy checking) techniques, but the system must then retransmit the data packet, slowing the throughput. To preserve a high throughput rate, remove data errors before they reach the UART.

By taking 15 samples during a bit interval, a circuit (Fig 1) can determine the probable value of that bit by a majority vote. A sampling clock shifts each set of 15 samples into a pair of serial-in, parallel-out shift regis-

ters (IC₁ and IC₂). Counter IC₃ then sums the number of 1 bits. If eight or more of the 15 samples are high, for example, the output will be high. To ensure that all 15 samples are taken within a bit interval, the sampling-clock frequency should be somewhat higher than 15 times the data's baud rate. Further, the sampling-clock frequency should be an exact multiple of the baud rate to avoid altering pulse widths in the bit stream.

The circuit includes additional logic to control the time of transitions at the data-output terminal. (The output remains low until nine of 15 samples are counted high, then remains high until nine of 15 are counted low.) The processor's reset signal drives the Enable terminal; or, for half-duplex communications, the transmitter's transmit-enable output can drive the Enable.

EDN

To Vote For This Design, Circle No 748

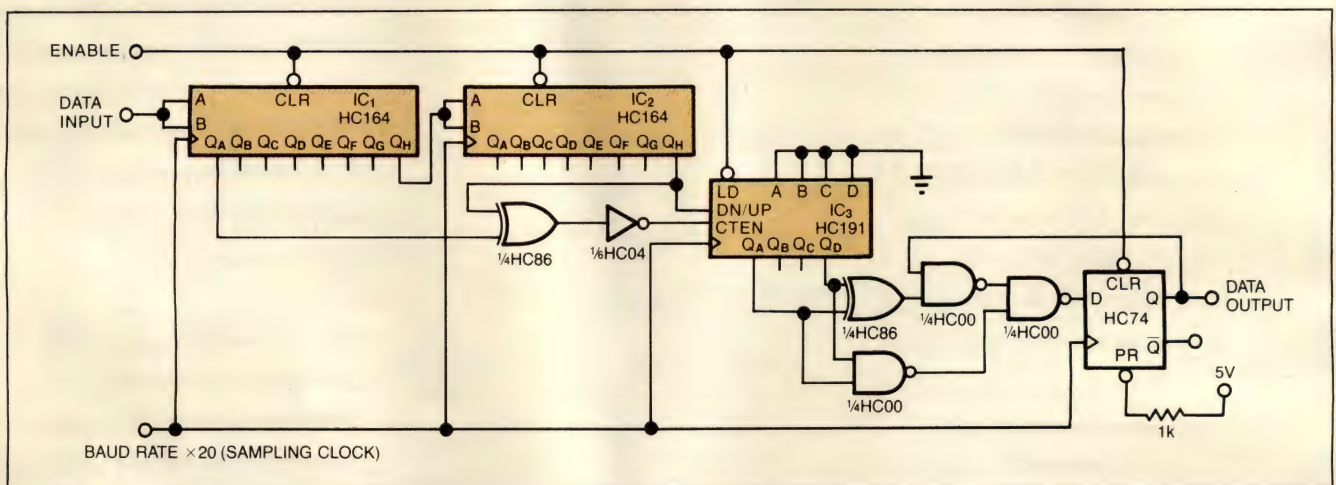


Fig 1—Two shift registers sample each bit interval 15 times to decide whether the bit should be considered 1 or 0. Majority rules—ie, eight or more 1s set the data output high.

Program a sine-wave oscillator's frequency

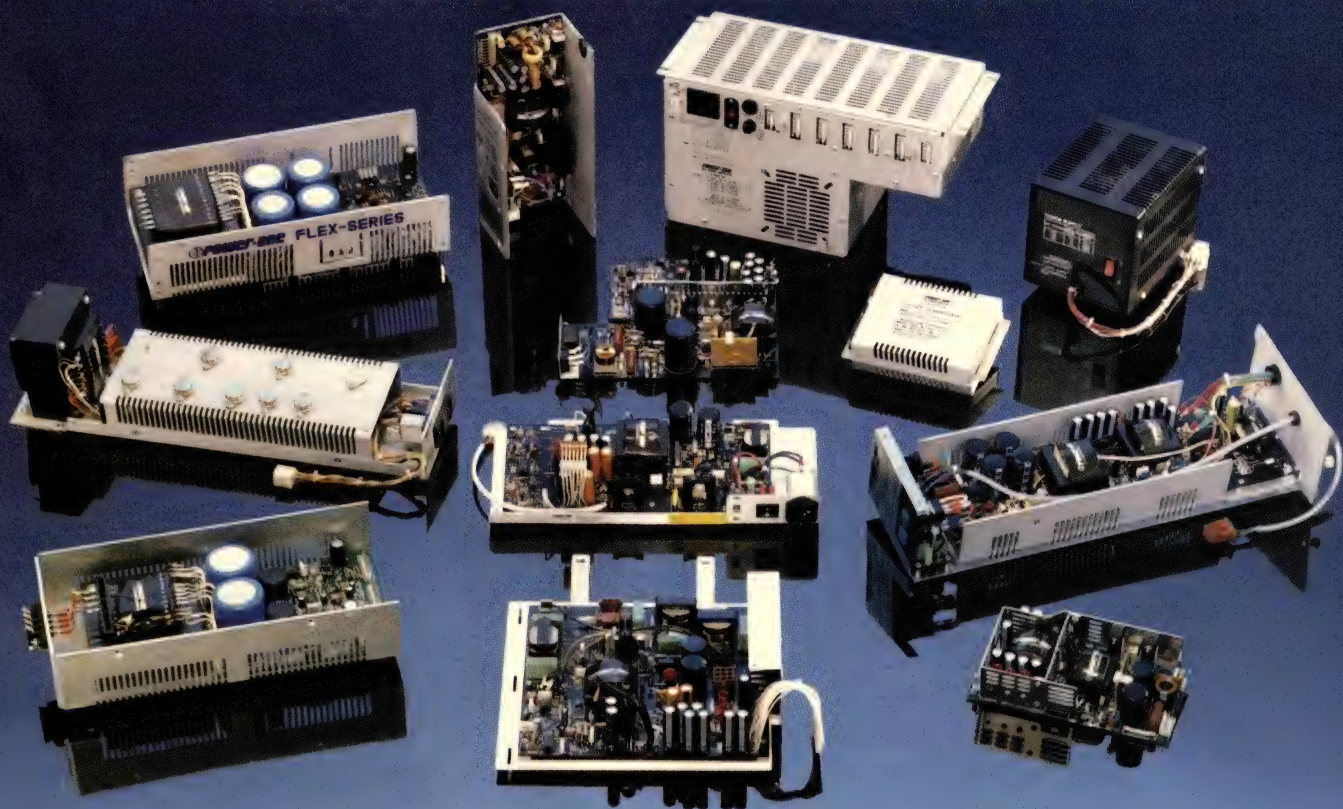
Shvalbe Gershon
Holon, Israel

Fig 1 depicts a sine-wave oscillator that produces a constant-amplitude, programmable-frequency audio signal. You derive the basic timing frequency from a μ P

and a programmable-interval timer chip.

The 8748 microcomputer divides its 6-MHz crystal-clock frequency by 3 and provides the resulting 2-MHz signal at pin 1 when the CPU executes an ENTO CLK instruction. Pin 1 feeds the signal through a noninverting buffer (IC₂) to the CLK₀ input of the 8253

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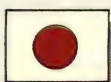
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DESIGN IDEAS

programmable-interval timer (PIT). The PIT includes three fully independent, 16-bit counters, but in this case it only uses one. By programming the 0 counter's initial state and count, you can obtain a desired frequency (F_{CLK}) at the Q_0 output (pin 10).

The CMOS divider IC_5 divides F_{CLK} by 100 and feeds the result to the input of a fourth-order Butterworth lowpass filter (IC_6), which extracts the fundamental sine-wave frequency. (Filter gain is about $\frac{1}{3}$; you may need an output amplifier, as shown within the dotted lines.) The filter realizes a fourth-order response by cascading two second-order functions: The A side has a

gain of 0.3 and a Q of 0.504, and the B side has a gain of 1 and a Q of 1.306.

Because the programmed frequency F_{CLK} also serves as the switched-capacitor filter's clock input, the filter's output and cutoff frequencies maintain a fixed relationship. Thus, the output remains at a constant amplitude for any frequency you program over a 5-decade range.

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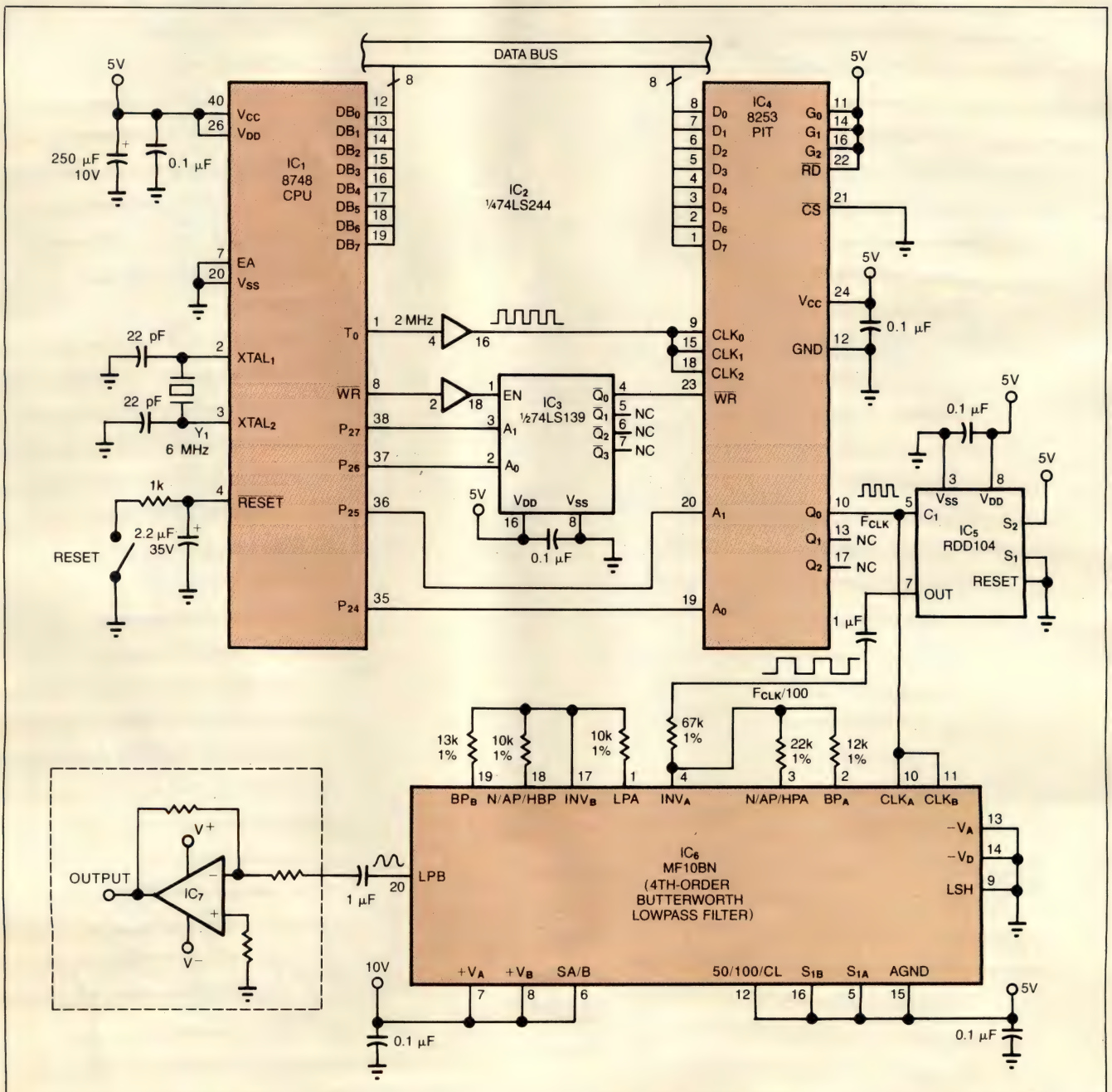
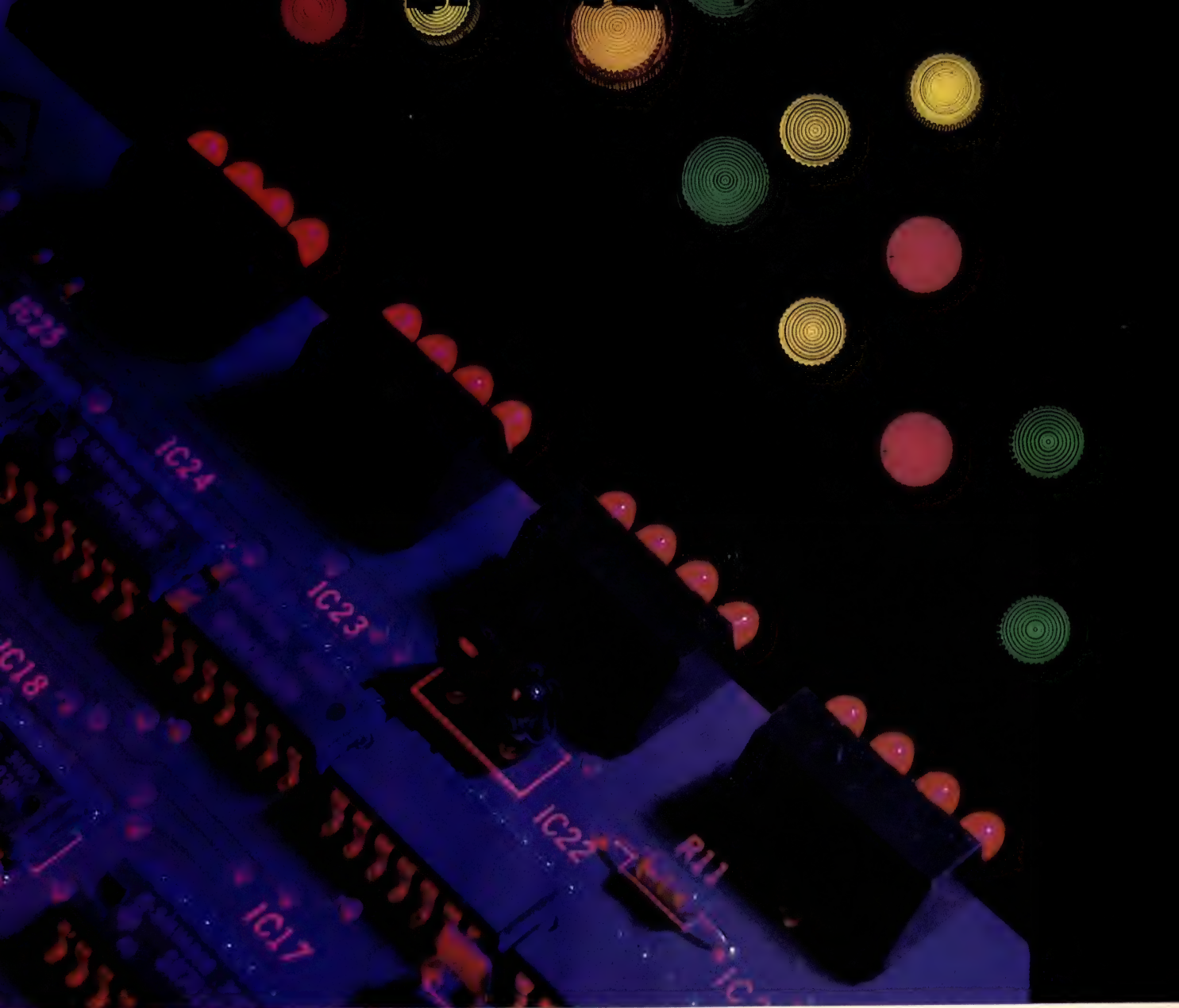


Fig 1—This microcomputer-controlled system produces a constant-amplitude, programmable-frequency audio output. Frequency range spans five decades to 20 kHz.



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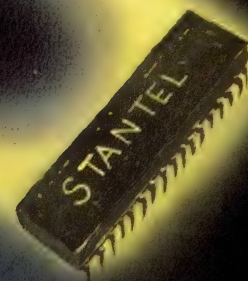
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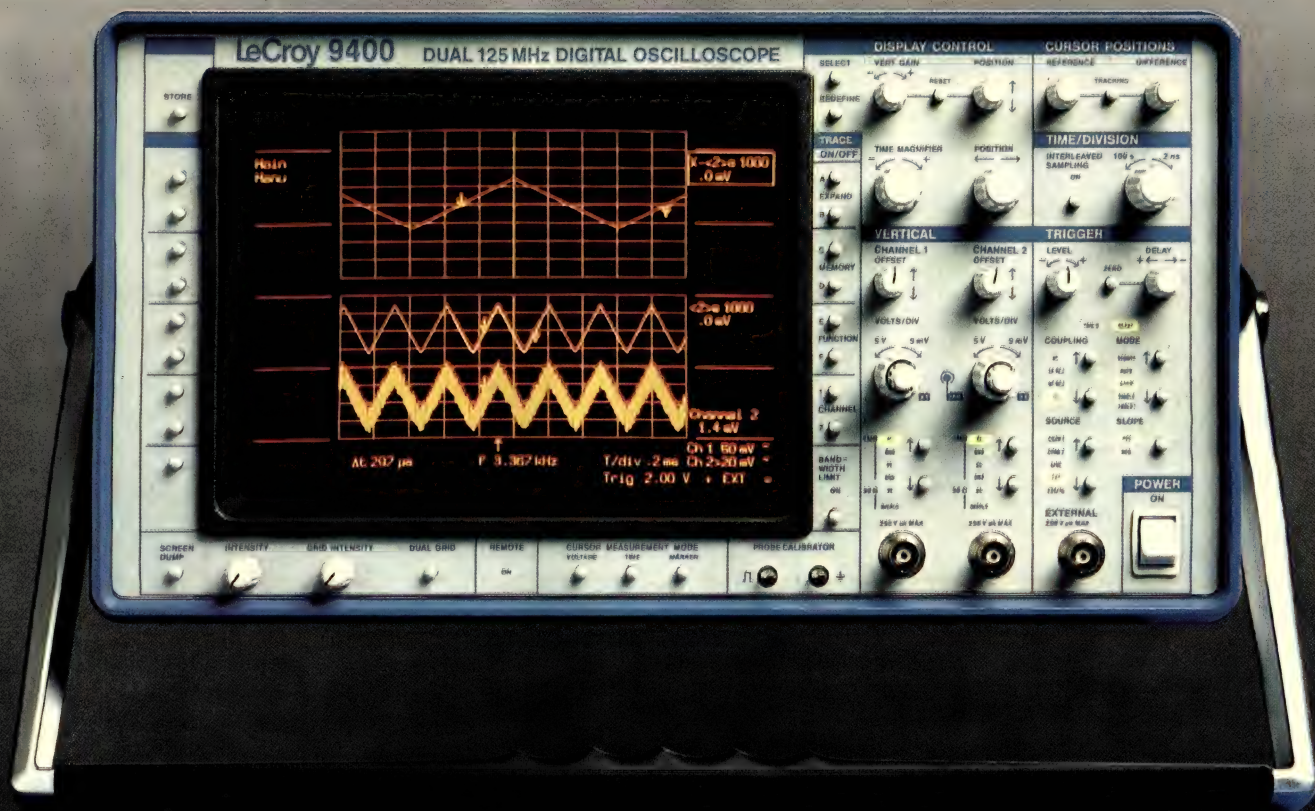
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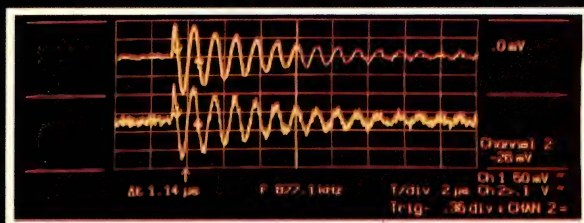
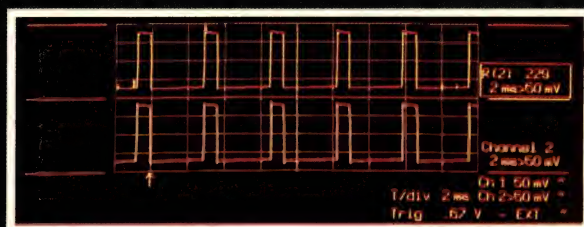
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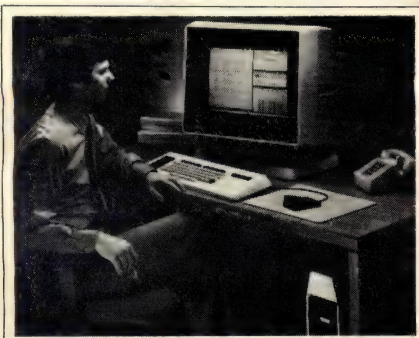


Top: Summation averaging over 1,000 waveforms, expansion and high resolution frequency measurement all shown in one display.

Middle: Extrema Mode shows glitches in digital circuitry, logged over 229 acquired waveforms.

Below: Digital filtering with a 9-point filter smooths noisy transient.

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LOGIC ACCELERATOR

The Design System can simulate designs that have more than 250,000 gates at the rate of 5M evaluations/sec. It provides tools for rules checking, testability, and fault simulation as well as design-entry and -analysis tools. The software runs on the Apollo workstation. With the rules checker, a user can define and create additional rules to be used in designing the system. A test-pattern generator accommodates structured designs. All single stuck-at faults for designs containing scannable registers are covered. The accelerator incorporates a logic simulator that performs leveled compiled-code and event-driven simulation. A fault simulator is also included along with the company's Cosimulator, a RISC that accelerates simulation computation. Design-entry tools include a schematic-design editor; a graphics entry program; a design language (to define the function and properties of logic designs); a symbol editor (a program for generating the graphic symbols of logic objects); cell libraries, timing libraries, and a librarian; and an automatic logic documenter. \$140,000; upgrade for Apollo users, \$85,000.

Aida Corp, 3375 Scott Blvd, Suite 340, Santa Clara, CA 95054. Phone (408) 748-8571.

Circle No 350

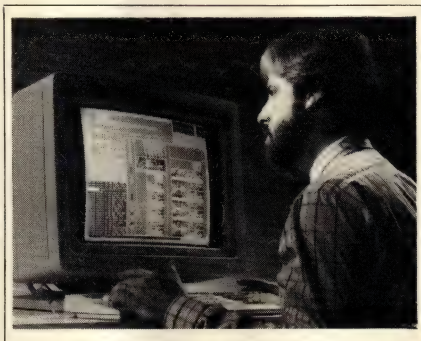
PC-BASED CAE

Two CAE systems, the Entry Designer AT/EG and the Logic Designer AT/EG, are based on the IBM PC/AT, IBM's enhanced

graphics adapter, and its 13-in. 640×350-pixel enhanced color monitor. The package includes an 85M-byte hard disk, an optical mouse, a 32-bit coprocessor, a 2M-byte RAM, and the AT&T Unix, System V. The Entry Designer AT/EG is a graphics entry system that provides schematic capture. In addition to the hardware, it includes this vendor's graphics editor. You can enter a schematic at your desk and then transfer the design via Ethernet or the RS-232C interface to another system. The Logic Designer AT/EG is identical to the first package except that it also contains Valid-compiler and Valid Packager. Both packages are available either as turnkey systems or as adjuncts to existing PC/ATs. Turnkey Entry Designer AT/EG, \$17,950; adjunct, \$7950; turnkey Logic Designer AT/EG, \$22,950; adjunct, \$12,950.

Valid Logic Systems Inc, 2820 Orchard Parkway, San Jose, CA 95134. Phone (408) 945-9400. TLX 3719004.

Circle No 351



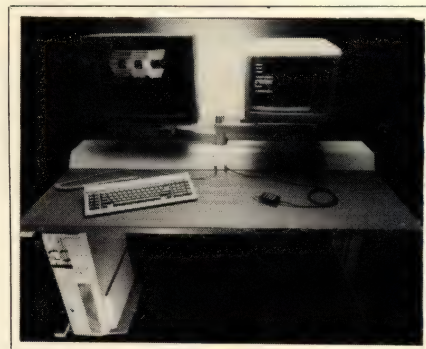
COLOR WORKSTATION

The VAXstation II/GPX is a MicroVAX II computer that features a VLSI color-graphics coprocessor. In addition to increasing the speed of the workstation's graphics, the coprocessor frees the CPU for other computations. Offered with Ultrix (an implementation of Unix), the workstation also supports the company's VMS operating system. The graphics coprocessor provides image copy and vector drawing; pattern fill, clipping, scaling and zoom;

and scrolling. The coprocessor can operate to 560M bps; it performs operations on all planes in parallel. The package's X-Window system provides network-transparent windowing. The workstation includes DECnet and Ethernet. Entry-level color system, \$35,000; extended color system, \$53,800.

Digital Equipment Corp, 146 Main St, Maynard, MA 01754. Phone (800) 344-4825.

Circle No 352



PC-BOARD CAD

The STL-10 pc-board workstation comes with an instant redraw facility (Symzap) that eliminates the waiting time during pan and zoom operations. The workstation offers an automatic router and two color monitors: a 19-in., 1024×768-pixel model and a 13-in., 640×400-pixel model. The desktop is an integrated digitizing surface. \$39,950. Delivery, 60 days ARO.

Chancellor Computer Corp, 1101 San Antonio Rd, Mountain View, CA 94043. Phone (800) 222-2660; in CA, (415) 969-5000.

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DRAFTING SYSTEM

The Pro-CAD 286 features a Business-Pro computer bundled with AutoCAD software from AutoDesk Inc. Systems are available with either 21M- or 40M-byte Winchester disk drives. The preconfigured package includes the system unit, 640k bytes of RAM, a 1.2M-byte floppy-disk drive, a TI-mode CRT controller, a 720×300-pixel color

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display, an 80287 numeric coprocessor, MS-DOS version 3.0, and AutoCAD with Advanced Drafting Extensions-3. Expansion options include additional memory, disks, communications, and an IBM-mode controller for PC/AT-compatible applications. The 21M-byte version, \$9950; 40M-byte version, \$11,200.

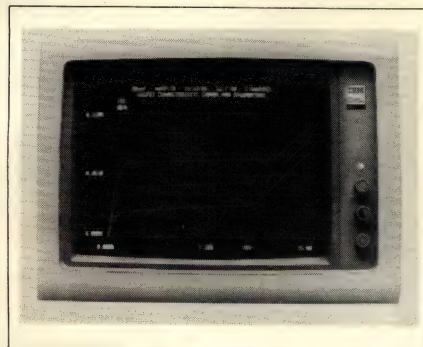
Texas Instruments Inc., Data

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EEsof Inc, 31194 La Baya Dr, Suite 205, Westlake Village, CA 91362. Phone (818) 991-7530. TLX 384809.

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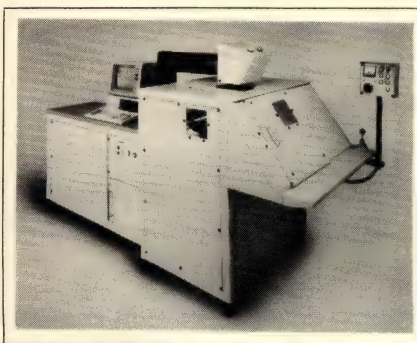
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Keithly 193	6-1/2	✓	✓	✓	✓	Option	Option	10 Channel	\$3560
HP 3457A	6-1/2	✓	✓	✓	✓	✓	✓	10 Channel	\$3250
Solartron 7060 A	6-1/2	No	✓	✓	✓	✓	✓	16 Channel	\$3740

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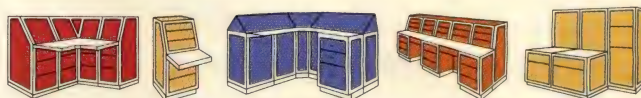
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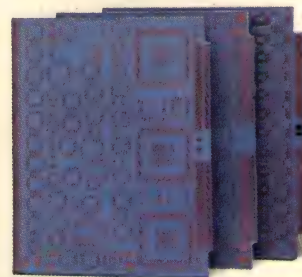
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Integrated Systems Inc, 101 University Ave, Palo Alto, CA 94301.
Phone (415) 853-8400.

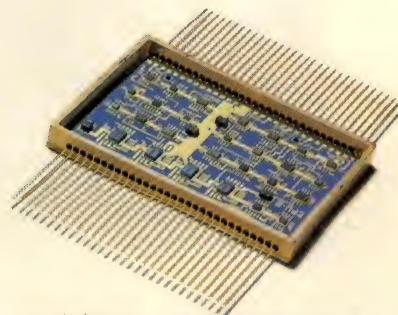
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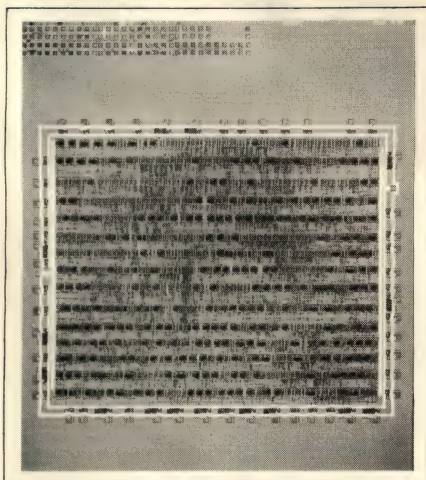
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Datron Instruments Inc. 4125 S.W. Martin Highway, Stuart, Florida 33497 1-800-327-0938 (305) 283-0935 Telex 525724
Datron Instruments Ltd. Hurricane Way, Norwich Airport, Norwich NR6 6JB England (0603) 404824 Telex 975173

CIRCLE NO 146

COMPUTER-AIDED ENGINEERING



STANDARD-CELL CAD

A 3- μ m CMOS standard-cell library allows you to design ICs that take advantage of the fabrication services of the Mosis project at the University of Southern California. Coupling the CMOS 3 library with the company's software provides integration between the schematic and physical layout. Design is correct by construction, and physical layouts are automatically generated. The manufacturing data is produced automatically and sent to the Mosis project. Prototyping costs \$3500 to \$10,400, depending on chip size. Packaged chips returned in eight to 10 weeks. Kits, \$400.

Mentor Graphics Corp., 8500 SW Creekside Pl, Beaverton, OR 97005. Phone (503) 626-7000.

Circle No 358

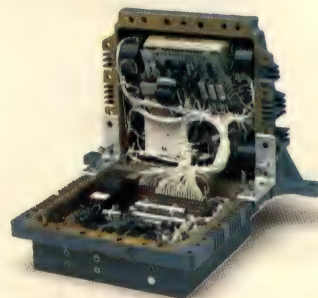
LAYOUT VERIFIER

The Dracula IC-layout verifier now runs on DEC's VAX 8800 dual parallel processor. In comparison to the single-processor, the throughput of the 8800 is 1.76 times greater. This performance can be maintained in systems with as many as five processors. Parallel Dracula, \$141,750.

ECAD Inc., 2455 Augustine Dr, Santa Clara, CA 95054. Phone (408) 727-0264. TLX 888040.

Circle No 359

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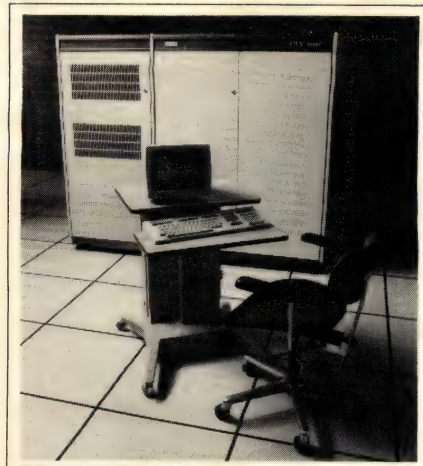
PORTABLE HARD DRIVE

Weighing 3.2 lbs, the Transpac is a portable Winchester drive that you can plug into an IBM PC or compatible computer. Its 3½-in. hard-disk drive and controller subsystem fit in a 2.6×4.15×5.9-in. metal case. Both a 10M- and a 20M-byte version are available. The Transpac uses the PC's power supply, specs a 70-msec

average access time, and withstands as much as 80g of shock. Interfacing the Transpac to your PC requires the use of one expansion slot. This nonvolatile data-storage system lets you back up your files at Winchester speed, transport those files, and share them with other PCs. It comes with a travel case. 10M-byte, \$1095; 20M-byte, \$1295.

Microcomputer Memories Inc., 9340 Owensmouth Ave., Chatsworth, CA 91311. Phone (818) 700-8000. TLX 181813.

Circle No 360

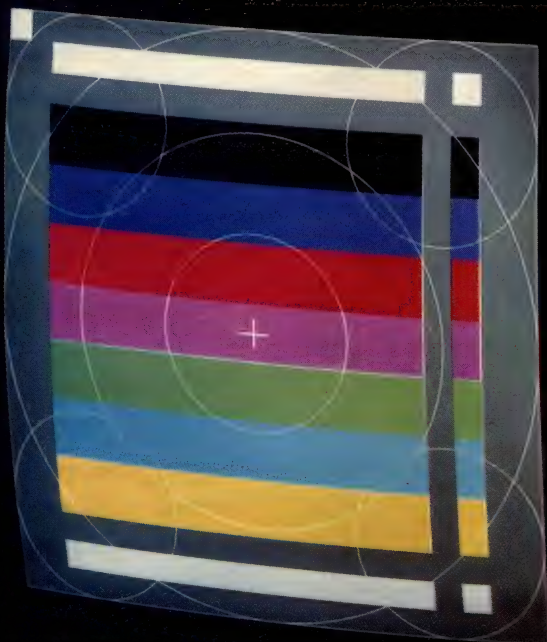


VAX COMPUTERS

Extensions of the company's VAX line, the VAX 8200, 8300, and 8800 computers incorporate a bus structure, VAXBI, that enhances their price/performance ratio in comparison to other VAX machines. Delivering the system performance and functionality of a VAX 11/780 com-

puter, the VAX 8200 comes in a smaller package at half the cost. The VAX 8300 gives you as much as 1.9 times the overall performance of a VAX 8200 in the same cabinet configuration. The VAX 8800 offers as much as 12 times the throughput of a VAX 11/780. The VAXBI bus is a general-purpose, 32-bit, synchronous backplane interconnect for nodes consisting of processor, mem-

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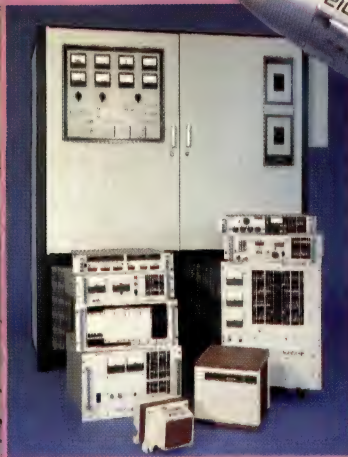
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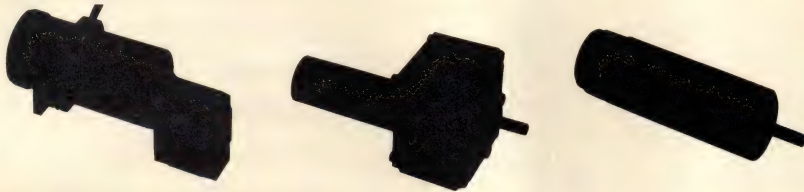
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XKD Corp., 101 Cooper Court, Los Gatos, CA 95030

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CIRCLE NO 150

COMPUTERS & PERIPHERALS

ory, and adapter modules. The bus supports as many as 16 intelligent interfaces with a maximum bandwidth of 13.3M bytes/sec. The VAX 8200 has one CPU; the 8300 and 8800 use a tightly coupled dual-processor system. The 8800 also incorporates as many as four VAXBI buses and features a 60M-byte/sec memory interconnect. 8200, from \$79,000; 8300, from \$122,000; 8800, from \$650,000.

Digital Equipment Corp., 146 Main St, Maynard, MA 01754.
Phone (617) 264-1031.

Circle No 361



DISPLAY TERMINALS

The HDS200 Series display terminals offer DEC VT220 compatibility. You can choose a 15-in. amber or green monitor. The ANSI terminal's minimum configuration includes four pages of memory, as many as three simultaneous host connections, and a menu-based configuration mode for data communications and key definitions. The HDS220G is similar to the HDS220 but adds a high-resolution (720x350-pixel) screen for graphics applications. The HDS220G also provides Tektronix 4010/4014 emulation, local printer support, and command keys such as arc, circle, draw, and fill. The HDS221 and HDS221G add a character set and keyboard for APL to the features offered by the HDS220 and HDS220G terminals. HDS220, \$995; HDS220G, \$1295; HDS221, \$1295;

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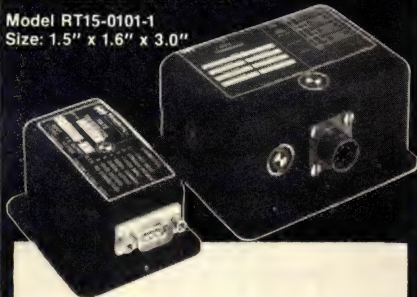
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Describes various circuits that can be added to sensor to allow use as angular position, rate, or acceleration transducer.



Manufactured under license from Hercules, Inc., U.S. Patent 3,500,691

Humphrey Inc.

CIRCLE NO 152

COMPUTERS & PERIPHERALS

HDS221G, \$1595. Delivery, 45 days ARO.

Human Designed Systems Inc., 3440 Market St, Philadelphia, PA 19104. Phone (800) 437-1551; in PA, (215) 382-5000.

Circle No 362

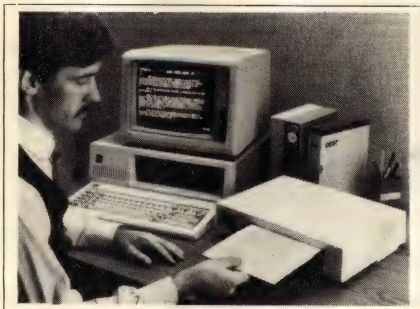


PC COLOR ENHANCER

By pressing two buttons on the peripheral Color Commander, you can override the display colors selected by your software on your IBM PC. You can then change the display colors to any other of the 16 IBM colors. The command buttons are clearly labeled, and the device comes with a demonstration/instruction disk for DOS 2.0 and higher. No software modifications are necessary. You place the device under your RGB color monitor and plug it into a PC or compatible computer. The unit operates in conjunction with all graphics software. \$359.

Perma Power Electronics Inc., 5601 W Howard Ave, Chicago, IL 60648. Phone (312) 647-9414.

Circle No 363



PAGE SCANNER

PC Scan lets you automatically transfer typed data from paper into your IBM PC or compatible computer. When you use the scanner in

conjunction with Text Pac, the company's character-recognition software, you can enter text into the formats of PC word-processing programs such as Wordstar and Multimate. The software also inserts all necessary tabs, centers, underscores, and document codes at a rate of 25 sec/pg. To activate the PC Scan, you insert the page you want to scan and type a single command. The device can scan pages as large as 8.5x14 in. The unit measures 4x11.5x16 in. and weighs 17 lbs. PC Scan, \$1995; Text Pac, \$595.

Dest Corp., 1201 Cadillac Ct, Milpitas, CA 95035. Phone (408) 946-7100.

Circle No 364



PORTABLE TERMINAL

Weighing less than 5½ lb, the Oyster terminal gives you VT-100 compatibility in a package that is half the size of a briefcase. The terminal incorporates a 16-line LCD that displays an 80-columnx24-line page of data. You can select baud rates as fast as 19,200. The unit comes with an internal, rechargeable NiCd battery pack that provides as many as 40 hours of continuous operation. You can also use an external ac/dc power supply. This terminal has an RS-232C interface and features a menu-driven setup routine. Using the menu, you can match signaling protocol between the terminal and your host computer. \$895.

GR Electronics, 1640 Fifth St, Santa Monica, CA 90401. Phone (213) 395-4774.

Circle No 365

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IWATSU'S NEW DS-6121

IWATSU is very proud to offer the best of both worlds, digital and analog. The DS-6121 is a 100 MHz equivalent time bandwidth oscilloscope, incorporating a 40 MS/s* sampling rate. It also functions as a 100 MHz analog oscilloscope with a 2 ns fastest sweep rate.

In addition, the DS-6121 can store 4 waveforms and a total of 6 front panel set-up conditions in nonvolatile memory. Voltage and time cursor measurements can be made

- 100 MHz analog/digital storage bandwidth
- 10 MHz single-shot digital bandwidth with interpolation
- Glitch capture available (Model DS-6121A)

in both analog and digital modes, enabling easier measurements of important parameters. The DS-6121 also packs powerful analytical capabilities, such as GO/NO GO judgement. This powerful feature allows it, without a controller, to compare an incoming waveform with a reference waveform and make a GO/NO GO decision. If an out-of-limit condition occurs, the DS-6121 will capture, save, and report it.

- 40 MS/s* sampling rate
- Fully-programmable interface
- 3-year warranty

*MS/s: Megasamples/second

CIRCLE NO 153

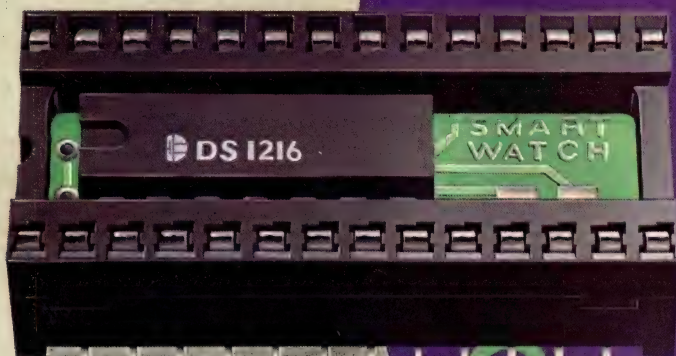


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Distributors: AVED, Advent, Almac,
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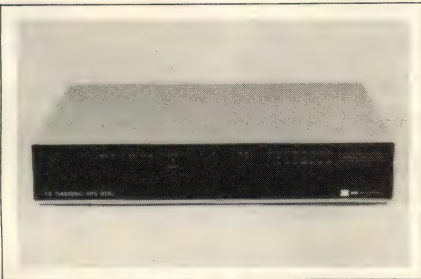


SCSI DRIVES

The 1370 Series of 5¼-in. Winchester disk drives with SCSI controllers gives you data-transfer speeds to 1.5M bytes/sec. Available in 77M- to 154M-byte capacities, each drive has a 16k-byte dual-ported FIFO buffer that eliminates any need for sector interleaving. The devices feature a 28-msec seek time that includes settling time. These drives also support a common command set that includes a copy command for backing up and restoring data without intervention by the host computer. The unit also accesses data without tying up the system bus. Model 1375, \$1625 (2500).

Micropolis Corp., 21123 Nordhoff St., Chatsworth, CA 91311. Phone (818) 709-3300.

Circle No 366



12k-BPS MODEM

The 12 Thousand BPS Dial modem gives you 12k-bps half-duplex point-to-point communications over the public switched telephone network. Features include forward error correcting and front-panel error indicators. The modem uses a μ P to perform its signal processing functions, such as automatic adaptive equalization, filtering, and demodulation.

Built-in monitors provide constant indications of system performance. If data throughput drops below 80% of 12k-bps rate, the modem automatically falls back to 9600-bps operation. \$2900.

Ark Electronic Products Inc., Box 2169, Melbourne, FL 32902. Phone (800) 228-0914. TLX 566537.

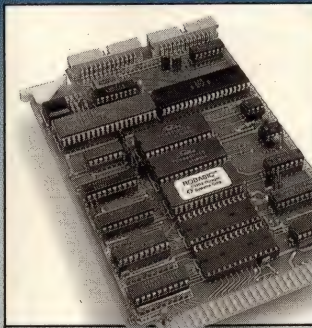
Circle No 367

MOUSE

The M3/100 mouse comes with an RS-232C or TTL output; you can add an intelligent interface. Its main-drive ball uses high-impact, low-friction bearings with a self-cleaning bearing surface. The unit features the noncontacting solid-state pulse generators for low maintenance. It has three user-definable

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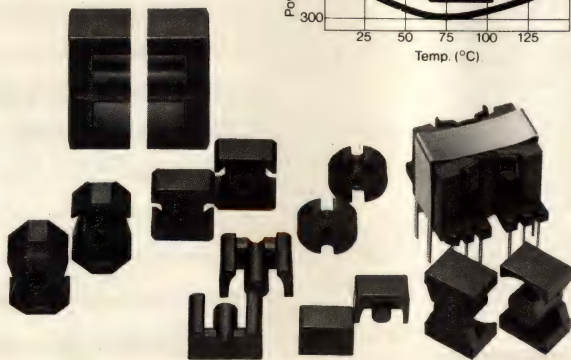
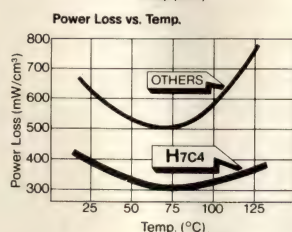
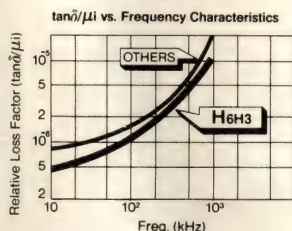
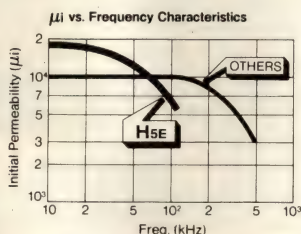
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COMPUTERS & PERIPHERALS

switches, an output resolution of 100 counts per in., and an operating temperature range of 0 to 50°C. You can dismantle the mouse for cleaning. Its optional intelligent interface handles a number of data-input housekeeping functions. M3/100, \$169; intelligent interface, \$219.

Penny & Giles Ltd, 1640 Fifth St, Santa Monica, CA 90401. Phone (213) 395-4774.

Circle No 368



SPEECH MODULE

This audio annunciator, the Digivoice DV-1500, provides playback processing of encoded speech from onboard EPROM as well as from external devices. The EPROM can store five minutes of speech. A Z80 microprocessor control lets the DV-1500 reproduce natural-sounding audio responses from digital signals. The unit uses speech algorithms and can support RS-232C, Centronics parallel, and program-mable I/O interfaces. By storing downloaded instructions, a RAM buffer minimizes the load on the host processor. The unit also comes with driver software for common protocols, high- and low-level audio outputs, and an externally initiated self-test. You can use the voice board in the DV-1500 as a stand-alone annunciator or as a plug-compatible board in a Multibus or VME Bus system. VME Bus version, \$980; Multibus version, \$1150.

Wespercop, 14511 New Myford Rd, Tustin, CA 92680. Phone (714) 730-6250.

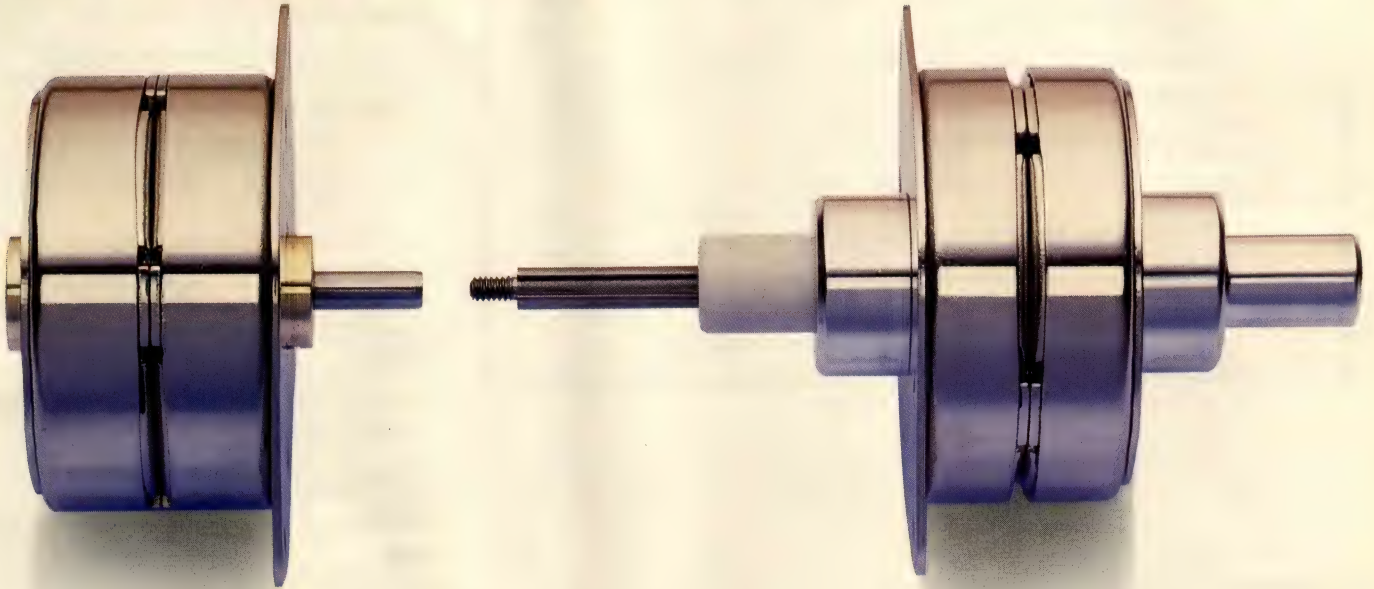
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WHY THIS STEPPER MOTOR SHOULD SELL YOU ON THIS LINEAR ACTUATOR.

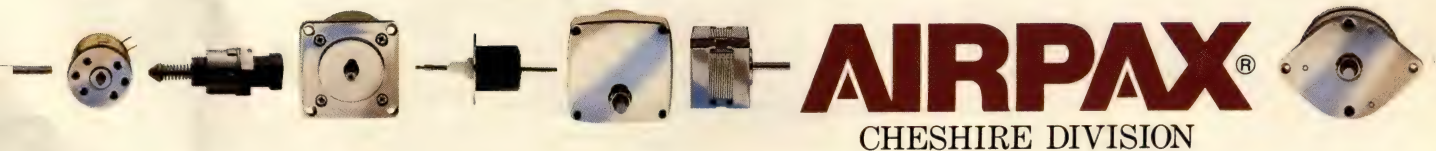
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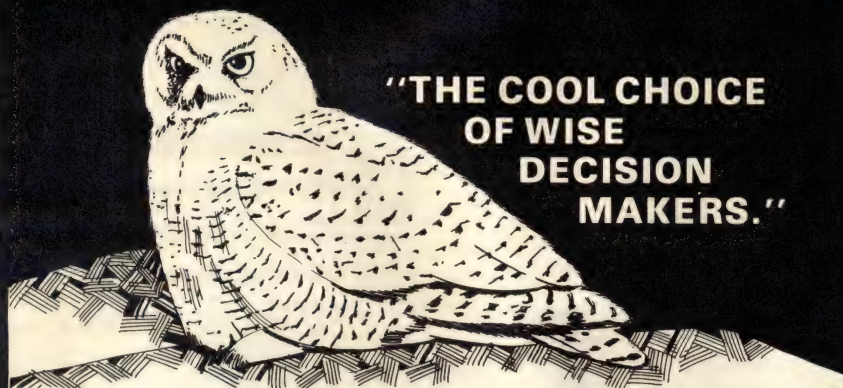
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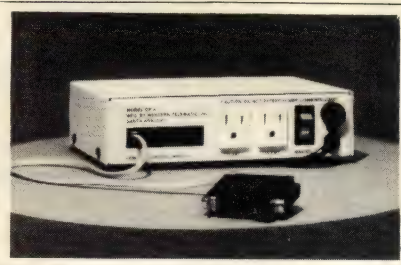
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24-C

CIRCLE NO 159

COMPUTERS & PERIPHERALS

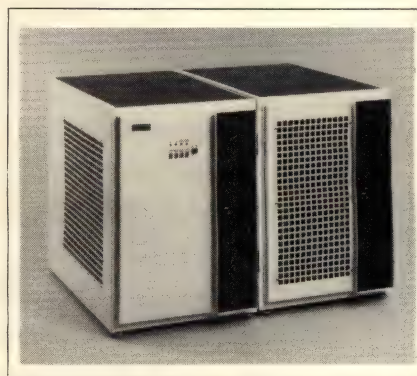


POWER SWITCH

With Call-Power, you can perform unattended data communications without leaving your computer on. This power switch turns your computer system on and off via modem commands. You plug your computer's power cord into the switch and install the unit's call-detect module between the computer's modem and the computer. It lets the modem answer an incoming call with the computer turned off. When the modem answers, the power comes on. When the modem hangs up, the power goes off. The device can serve as many as four modems at once, has a surge protector and a circuit breaker, and features a bypass switch for local control. \$295.

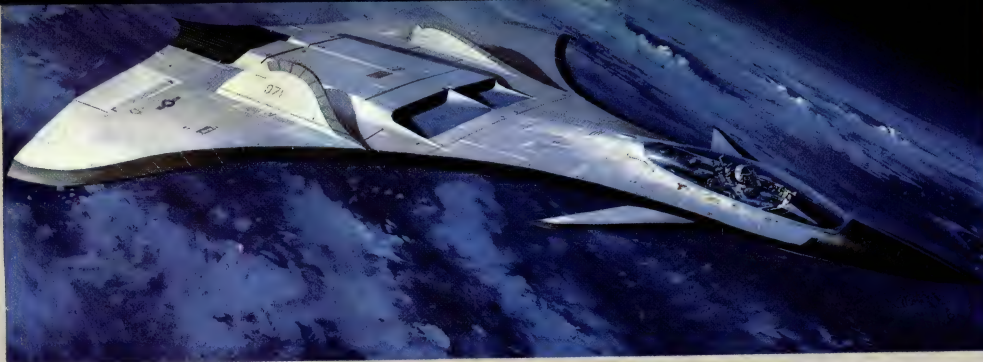
Western Telematic Inc, 2435 S Anne St, Santa Ana, CA 92704. Phone (800) 854-7226; in CA, (714) 979-0363.

Circle No 370



TEMPEST COMPUTER

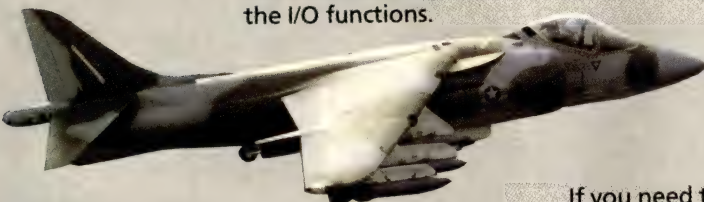
This Tempest-certified supermini-computer for protecting classified information, the T3350, features a 0.85-MIPS, 32-bit CPU that is available in four system configurations. A standard system includes 4M



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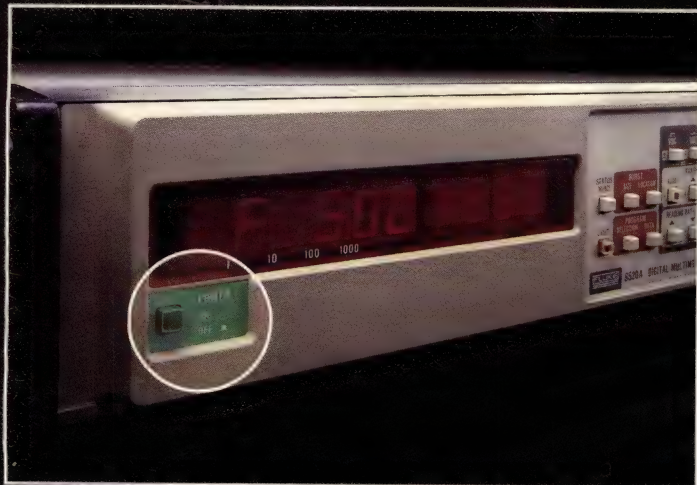
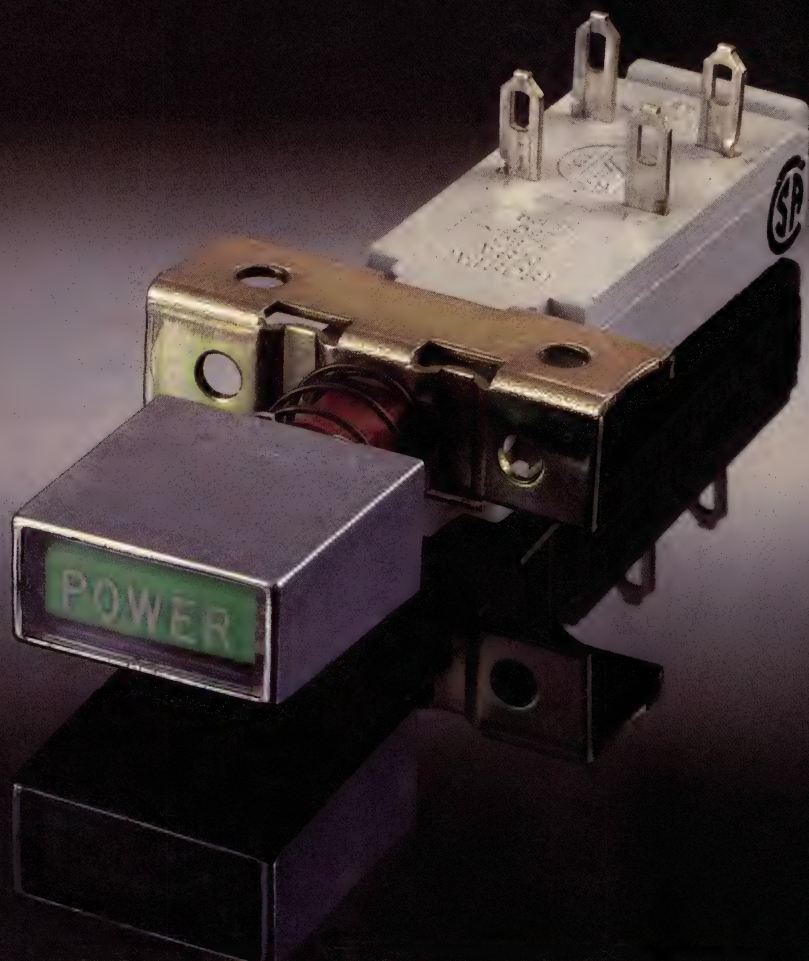
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COMPUTERS & PERIPHERALS

bytes of MOS RAM, a 315M-byte hard-disk drive, and 16 asynchronous terminal ports. The system includes two cabinets: one for the CPU, memory, and I/O controllers; the other for disk drives and tape-storage devices. Configurations can include as much as 8M bytes of main memory, as many as 32 terminal ports, a streaming-tape drive, and as much as 16k bytes of cache memory. This system meets the requirements of NACSIM 5100A, a US National Security Agency standard that specifies limits for electronic signals radiated by computer equipment. An international version of the T3350, which runs on 50-Hz power, is also available. From \$120,450.

Prime Computer Inc., Prime Park, Natick, MA 01760. Phone (617) 655-8000.

Circle No 371

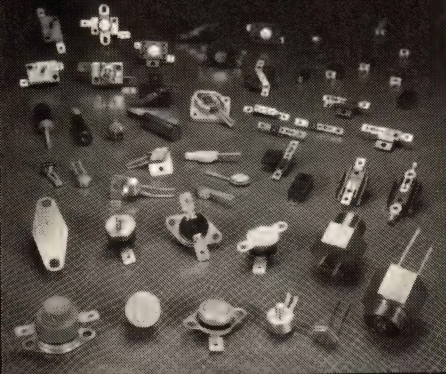
PRINthead

Capable of printing at rates to 360 cps, the Model 100 impact matrix printhead can replace the Epson FX-80 and FX-100 printheads. Its service life is >200 million characters. This device weighs 52g but delivers sufficient impact force to print a 6-part form. The Model 100 offers a vertical dot density of 72 dots/in; its 1-piece magnetic structure and heat sink allow high duty cycles. \$28 (OEM qty).

DH Technology Inc., 575 Maude Ct, Sunnyvale, CA 94086. Phone (408) 738-2082. TLX 171570.

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This 6-line×40-character display, Model 28400-99, uses components that meet military standards and has an extended operating range of -40 to +85°C. The character height is 5.05 mm; the format is dot matrix. The display requires 5V dc. An onboard μ P controls all display functions and interfaces to an 8-bit, parallel TTL data bus. The module displays the 96-character ASCII set as well as European characters and scientific symbols. It can also display user-defined fonts. Display characters are blue-green. You can

dim the display. \$3500 (10). Delivery, 12 weeks ARO.

IEE Inc., Industrial Products Div, 7740 Lemona Ave, Van Nuys, CA 91405. Phone (818) 787-0311. TWX 910-495-1707.

Circle No 373



SWITCH ASSEMBLIES

TH Series thumbwheel assemblies are available in 2-, 3-, and 4-digit models with BCD outputs of either positive or negative logic. You can

also order them bused (one, two, four, or eight outputs tied together with grounds separate) or not bused (all inputs and grounds separate). The design features an integral bezel for mounting and screw terminals for wiring. Connections are labeled. The sealed switches are protected against moderate amounts of dust and dirt. (A different assembly is available for harsh environments.) 2-digit assembly, \$44.95; 3-digit, \$54.30; 4-digit, \$65.

Cherry Electrical Products Corp., 3600 Sunset Ave, Waukegan, IL 60087. Phone (312) 360-3413.

Circle No 374

HIGH-SPEED MODEM

The LDM35 limited-distance modem features baud rates of 19.2k at 2500 ft and 9.6k at 2 mi. The modem includes optical isolation, diagnostic LEDs, a null-modem switch, industrial surge protection,



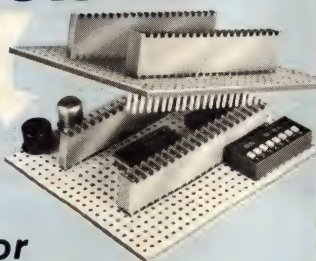
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See EEM Vol. 2, 1149-1152

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F

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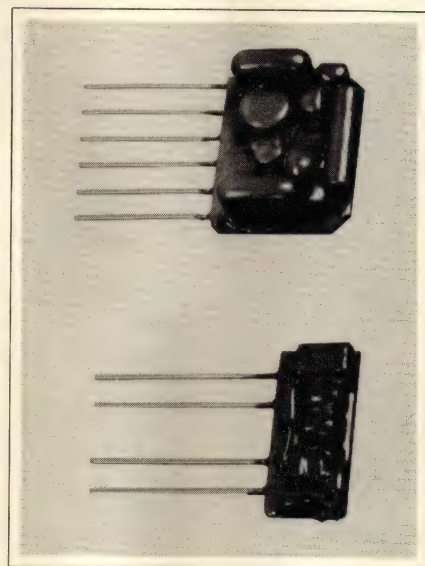
and a selection of connectors. It also communicates over two twisted-wire pairs. This feature overcomes the distance limitations of RS-232C ports and allows you to connect computing and peripheral devices that are miles apart. The unit requires no external power because its circuits derive power from the RS-232C signals. The manufacturer uses low-power circuits and an optically isolated receiver to make this feature possible. \$77.

Burr-Brown Corp, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. TWX 910-952-1111.

Circle No 375

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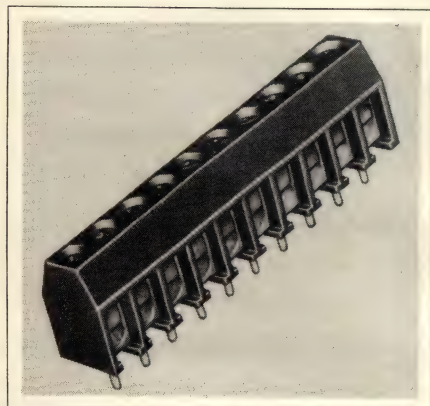


delay, interval, and triggered interval delays. The timing ranges cover 0.1 to 1, 0.5 to 5, 5 to 50, 30 to 300, 1 to 10, 12 to 120, 3 to 30, and 6 to 60 sec. Input voltages are 120V, 24V, and 12V ac; and 240V, 48V, 24V, and 12V dc. From \$8 for on delay and from \$12 for other timing func-

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Instrumentation & Control Systems Inc, 520 Interstate Rd, Addison, IL 60101. Phone (312) 543-6200. TWX 910-991-5945.

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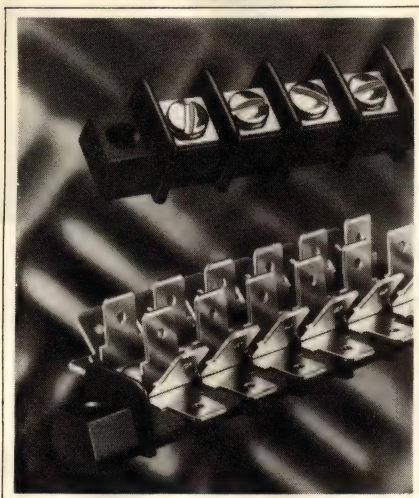
base, and straight- or right-angle pc-board-compatible terminals. Five-mm center strips are available with 2 to 32 positions; 10-mm center strips have 2 to 16 positions. The strips include captive top screws. A wire-protector plate on each position distributes the pressure on the wire. All terminals are tin-plated copper for high-reliability solder connections. A 10-position unit, \$1.25 (1000).

Magnum Electric, 6385 Dixie Hwy, Erie, MI 48133. Phone (800) 521-0330.

Circle No 377

BARRIER STRIPS

The 25000 Series barrier terminal strips are rated at 20A. They are made of a general-purpose phenolic material and come with either screw terminals or low-cost rivets. The open-back devices have terminals spaced on $\frac{7}{16}$ -in. centers. Bar-

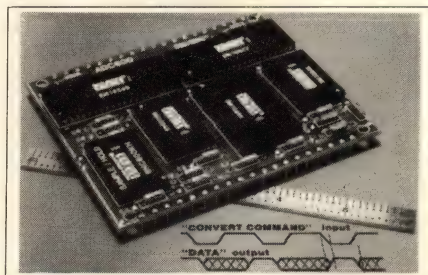


rier height is 0.50 in. and width is 0.69 in. They can be furnished with one to 30 circuits. Hardware options include a wide variety of terminals and jumpers. Top terminals come in 1-sided solder, 2-sided solder, and quick-connect styles; over-the-side terminals are also available. Strips with screws assembled and without terminal hardware, \$0.10 per circuit

(500). Delivery, six to seven weeks ARO.

Vernitron Corp, Beau Products Div, Box 10, Laconia, NH 03247. Phone (800) 367-2328; in NH, (603) 524-5101. TWX 710-364-1843.

Circle No 378

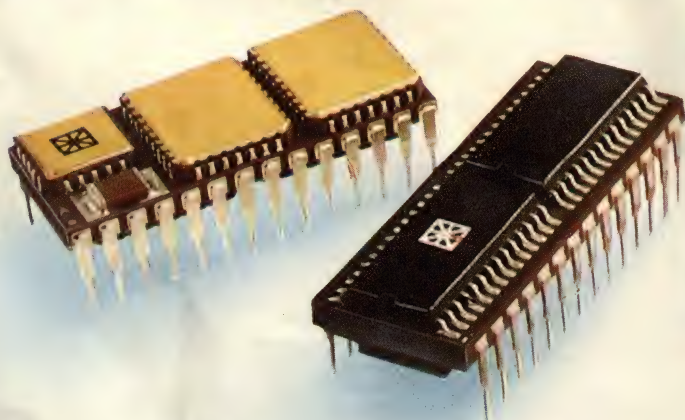


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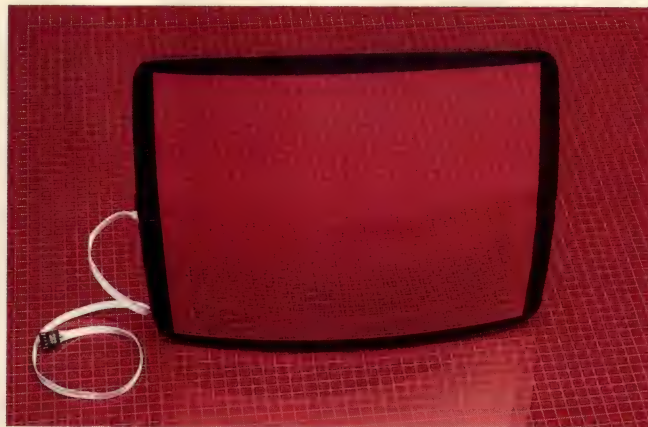
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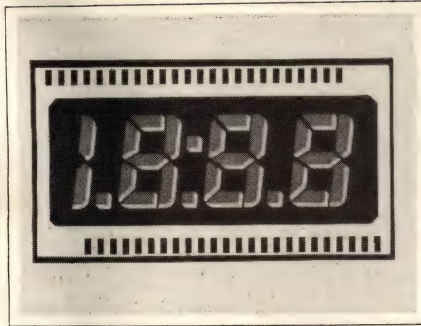
ELOGRAPHICS

105 Randolph Road Oak Ridge, Tennessee 37830 Telephone: (615)482-4100

ing circuits on a 4-layer pc board. Input impedance is 1.5 M Ω ; signal range is ± 1.25 V. Linearity error at 200 Hz is $\pm \frac{1}{2}$ LSB, gain error is $\pm 0.1\%$, and offset error is ± 2.5 mV. Power consumption is 8.5W. No codes are missing over the specified temperature range of 0 to 70°C. The S/H amplifier provides a 6-nsec aperture time with ± 25 psec uncertainty. Overall input bandwidth is 50 MHz. \$1795 (10).

Burr-Brown Corp., Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. TWX 910-952-1111.

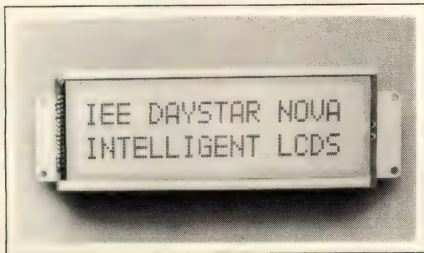
Circle No 379



colon. Contacts are on 0.1-in. centers with physical glass size measuring 1.5 $\times$ 2.75 $\times$.115 in. Options include polarizer, color filters, backlighting, and custom artwork. Evaluation units, \$48.95; production units \$9.90 (10,000/year).

UCE Inc., 24 Fitch St, Norwalk, CT 06855. Phone (203) 838-7509.

Circle No 381



DISPLAYS

The Daystar Nova Series 3803 2-line $\times$ 16-character LCDs are offered in both 20° and -20° preferential viewing angle versions for top or bottom viewing. These alphanumeric modules feature a temperature range of -30 to +85°C. Because they require 12 mA at 5V dc, they are suitable for battery-powered operation. The optional electroluminescent backlighting permits use in complete darkness and requires 125 mA at 5V dc. Onboard electronics contain all drive, refresh, and character-generation functions. Characters measure 0.36 in. high and can be read from 15 ft away. \$82 (100).

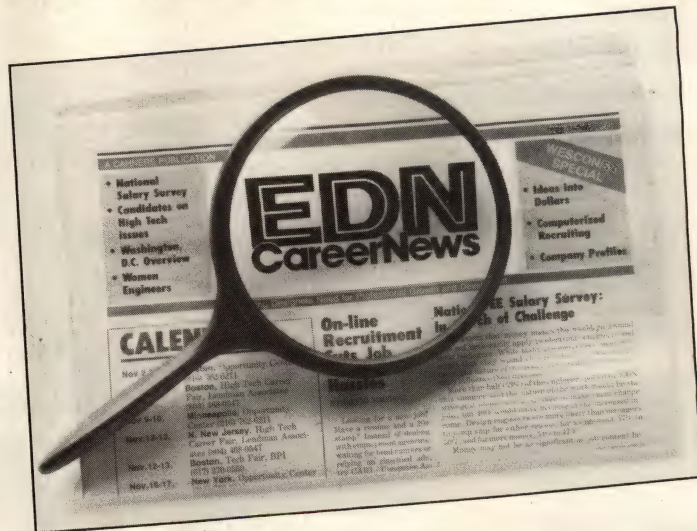
IEE Inc., 7740 Lemona Ave, Van Nuys, CA 91405. Phone (818) 787-0311. TWX 910-495-1707.

Circle No 380

LCD PANEL

This first in a series of LCDs, part #3.723-053D, provides simulated 3-D presentations. The device features 3½ digits that are 0.7 in. high, with three decimal points and a

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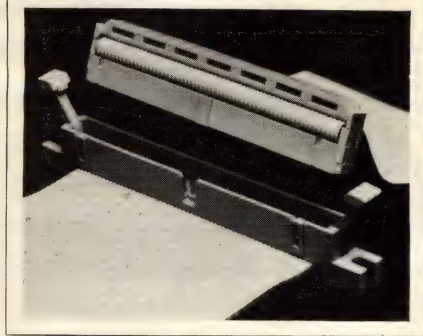
TOUCH SCREEN

The Series 3000 touch screens and controllers feature scratch- and abrasion-resistant, solid-glass, non-glare screens with a fused coating that cannot be punctured or torn, according to the manufacturer. Unlike infrared systems where beams are broken to establish X-Y coordinates, parallax is rarely a problem because you actually touch the screen to control the computer. The screens allow 80% light transmission with minimum dispersion and provide 100×100 touch points with

±2% accuracy. Fitting on 9- to 25-in. monitors, each screen has a self-adhesive gasket and is aligned simply by touching four points. Circuitry is static-safe to 20 kV. \$395 (OEM qty).

Interaction Systems Inc., 24 Munroe St, Newtonville, MA 02160. Phone (617) 964-5300. TLX 753582.

Circle No 382



PLUG CONNECTORS

These 0.1×0.1-in. grid male IDC connectors offer integral ejector-latch options. Ejector latches on the 4600 Series plug connectors ensure reliable socket-to-plug seating in high-vibration and -shock environments. The ejector function makes plug removal easier even in tight spaces, without strain on the cable or damage to pins, according to the manufacturer. Connectors are available in six sizes (14, 16, 24, 30, 36, and 64 pins). The devices feature

copper-alloy contacts with gold plating over nickel and a cantilever U-shaped contact. The 4650-6300, a 50-pin latched plug, \$5.48 (1000).

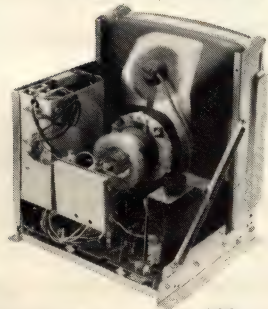
3M, Box 2963, Austin, TX 78769. Phone (512) 834-6563.

Circle No 383

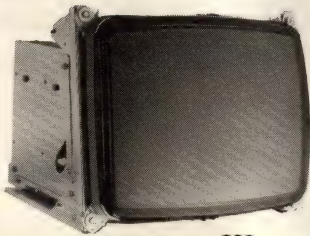
8-BIT VIDEO DACs

The RGB 3800/3808 D/A converters are hybrid circuits that each contain three channels of video output plus composite synchronizing- and blanking-output signals. These signals

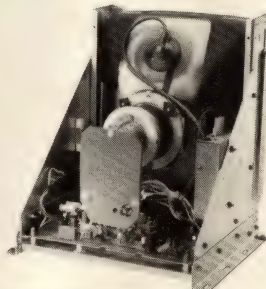
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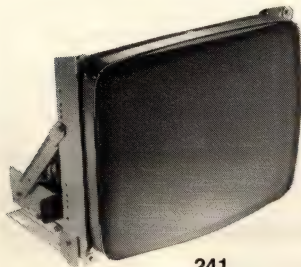
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Spectrum 14" (14") 239
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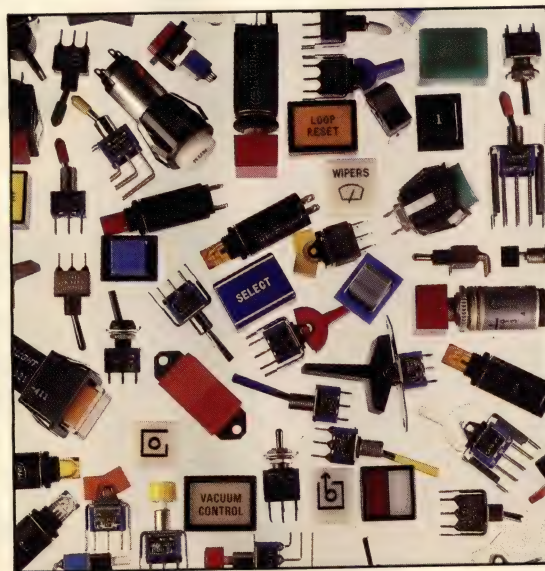
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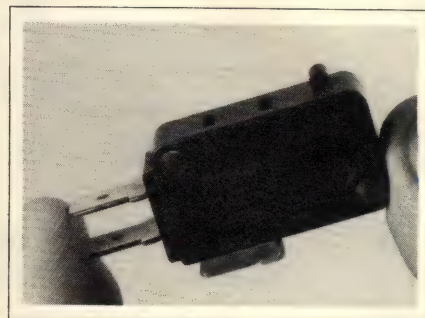
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COMPONENTS & PACKAGING

operate at pixel rates to 40 MHz. Each of the three converters in the 3800/3808 have 8-bit resolution and a color palette of 16.7M colors. The data inputs have latches, and the outputs do not require additional deglitching circuitry. The outputs drive a 75 Ω load directly with standard RS-343A video levels. These devices have TTL- and CMOS-compatible data and control inputs. The 3808 device also has three 256 $\times$ 8-bit RAM arrays for look-up tables, which offer a choice of any 256 of the palette's colors for each sweep. Both devices have an accuracy of 1 LSB. Power requirement is 4.5 to 5.5V. Operating temperature is 0 to 70°C. 3800, \$89.95; 3808, \$184 (100). Delivery, stock to 10 weeks ARO.

Intech Inc., Microcircuits Div, 2270 Martin Ave, Santa Clara, CA 95050. Phone (408) 988-4930. TWX 910-338-2213.

Circle No 384



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This spdt snap switch measures 1 $\times$ 0.625-in. It's UL listed and CSA approved at 21A and 1 hp, 125V ac or 2 hp, 250V ac. Actuation pressure is 200g max. The switch features 0.25-in. quick-connect terminals, a fracture-resistant plastic body, and silver-alloy contacts. It's available with a standard pin plunger or a variety of levers. \$1.

Pres:Air:Trol Corp., 1009 W Boston Post Rd, Mamaroneck, NY 10543. Phone (914) 698-2026.

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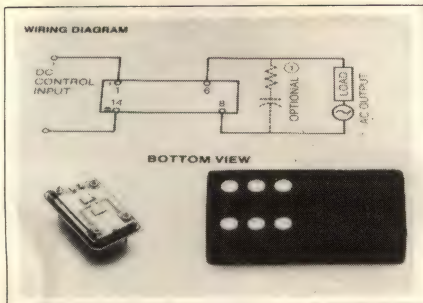


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NEW PRODUCTS: ICs & SEMICONDUCTORS



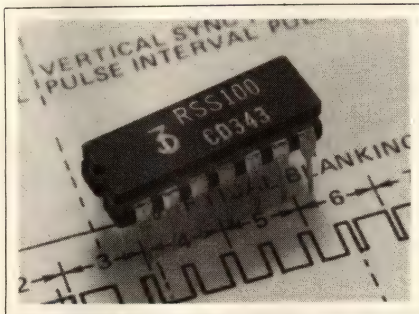
SOLID-STATE RELAY

The military-grade ChipSwitch solid-state relay (SSR) uses two power ICs controlled by 5 mA or less of LED current. The device supplies current as high as 3A at 280V. It features a surge-current rating of 30A and thermal resistance of 10°C/W junction-to-case or 50°C/W junction-to-air. The relay is a normally open SSR rated at 1.2A with precise zero-voltage turn-on and zero-current turn-off. It accepts logic-level inputs and provides ac-power control of valves, solenoids, small motors, lamps, heaters, and ac-pow-

er contactors. The device meets MIL specs R-28750/9 and 883B. In a hermetically sealed, low-profile DIP, \$35 (1000). Delivery, eight to 10 weeks ARO.

International Rectifier, 233 Kansas St, El Segundo, CA 90245. Phone (213) 772-2000.

Circle No 421



SYNC STRIPPER

The RSS-100A sync-stripper video IC and three passive components eliminate as many as seven ICs and 10 discrete components to produce

TTL-level, composite-sync pulses from standard- and nonstandard-input composite-video signals. Level detection provides internal dc restoration and sync-pulse detection; consequently, you can use the device with any video standard, regardless of scan rate, frame rate, or video bandwidth. The circuit operates from $\pm 5V$. In a 14-pin ceramic DIP, \$18.40 (100).

Third Domain, Box 35400, Tucson, AZ 85740. Phone (602) 299-8500.

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GATE ARRAY

The HM3500 low-power ECL/TTL gate array serves the full range of military-temperature requirements. An on-chip interface with ECL circuits eliminates the need for separate onboard signal converters in high-performance logic systems. The device uses a 2.5- μm , oxide-

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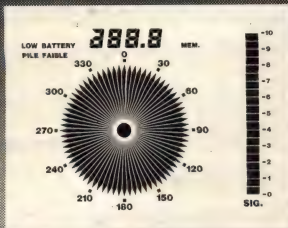
For detailed information on any of our systems, call or write (800) 228-MTOS, Industrial Programming, Inc., 100 Jericho Quadrangle, Jericho, NY 11753, (516) 938-6600, Telex: 429808 (ITT).

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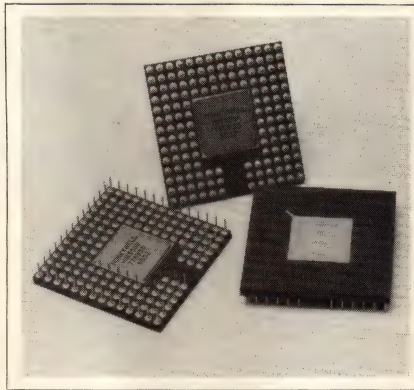
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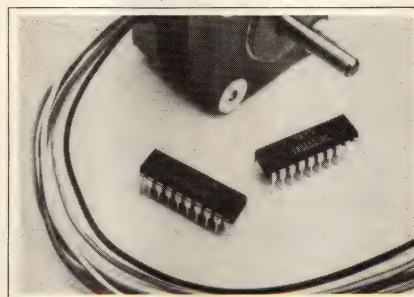
ICs & SEMICONDUCTORS



isolated, digital bipolar process and operates at system-clock frequencies greater than 300 MHz while dissipating only 3.5W. Typical internal current-mode-logic gate delays are 400 psec, with a fan-in/fan-out of two. The device contains 120 signal pins. The unit can interface with 10K or 100K ECL LSTTL devices, or any combination of the three at the same time. Price depends on the number of arrays to be designed, their complexity, volume ordered, and packaging. Nonrecurring engineering charges, \$60,000.

Honeywell, Digital Product Center, 1150 E Cheyenne Mountain Blvd, Colorado Springs, CO 80906. Phone (800) 328-5111

CIRCLE NO 423



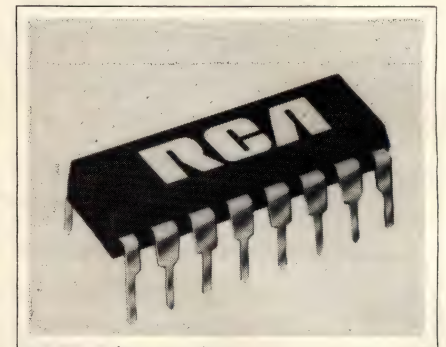
INTERFACE IC

The IXSE501 shaft-encoder interface IC links position and velocity feedback from motors to microprocessors. The device provides index-pulse reading and differential line-receiver input functions. Index-pulse reading provides error detection and homing as well as velocity control for high motor speeds. The RS-422-compatible, Schmitt-triggered differential line-receiver

input provides accurate pulse counting and noise immunity. The device also features quadrature decoding to quadruple shaft-encoder line resolution. The device has an optimized 8-bit digital design that allows high motor speeds: 38,000 rpm max with a 100-line encoder and a 2-kHz sample rate, and 3000 rpm max with a 2,500-line encoder and a 4-kHz sample rate. In a 20-pin DIP, \$9.80 (100).

Ixys Corp, 142 Charcot Ave, San Jose, CA 95131. Phone (408) 435-1900.

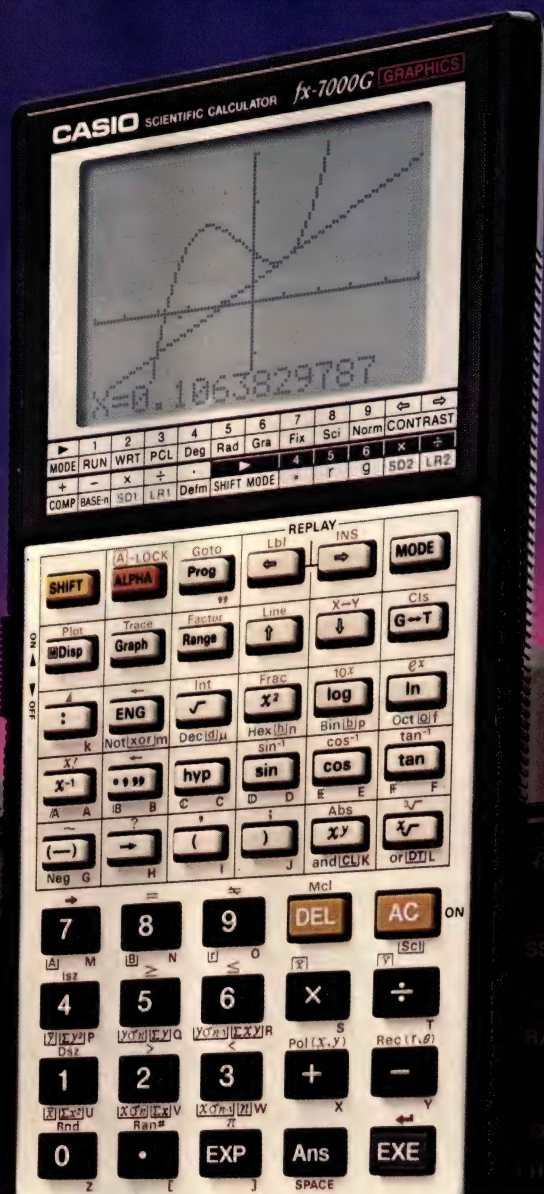
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POWER DRIVERS

The CA3219AE, CA3252E, and CA3242E are quad-gated, power-driver ICs that provide the high-current levels necessary to interface logic circuitry to the resistive and inductive loads found in digital control systems, instrumentation, and other applications. The first device is an inverting power driver; the second provides the same drive function in noninverting form. The third device is an inverting power driver that offers the additional advantage of short-circuit protection if the load current exceeds a predetermined value. All three drivers can switch 600-mA load currents without spurious change in the output state. The input gates of each driver are compatible with either TTL or CMOS logic devices operating from 5V power supplies. All the drivers contain internal diodes connected across the power-driver transistors to protect against voltage transients caused by inductive-load switching.

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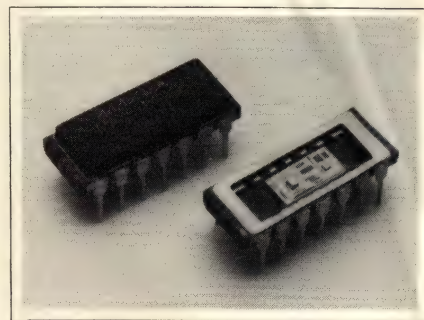
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ICs & SEMI-CONDUCTORS

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RCA Solid State, Box 2900, Somerville, NJ 08876. Phone (201) 685-6713.

Circle No 425



VOLTAGE REFERENCES

The MAX670 and MAX671 are precision 10V reference sources. Each device has Kelvin output and ground connections that result in load and line regulation independent of the line impedance between the voltage-reference output and ground. Laser trimming for initial accuracy and temperature drift ensures high precision over the commercial, industrial, and military temperature ranges. The MAX671 specs 1-ppm/ $^{\circ}\text{C}$ max output-voltage drift and an initial output accuracy of 1 mV. The MAX 670 specs 3-ppm/ $^{\circ}\text{C}$ max voltage drift and 2.5-mV initial accuracy. Both devices feature fine-trim adjustment, a maximum line regulation of 50 $\mu\text{V/V}$, a maximum load regulation 10 $\mu\text{V/mA}$, and a noise specification of 12 μV p-p typ over the 0.1- to 10-Hz bandwidth. The devices are 100% burned-in at 150°C . MAX670, from \$33.84; MAX671, from \$39.80 (100).

Maxim Integrated Products, 510 N Pastoria Ave, Sunnyvale, CA 94086. Phone (408) 737-7600.

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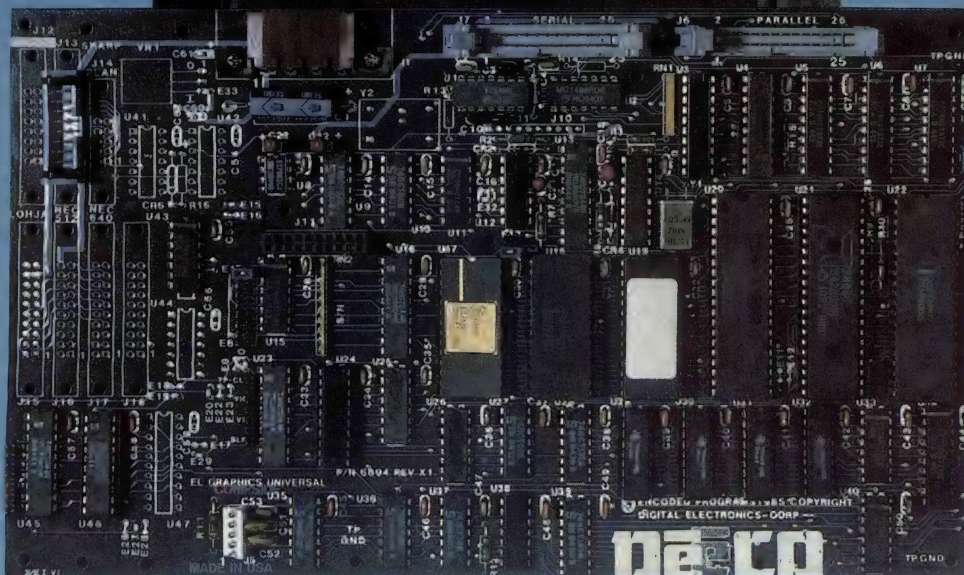
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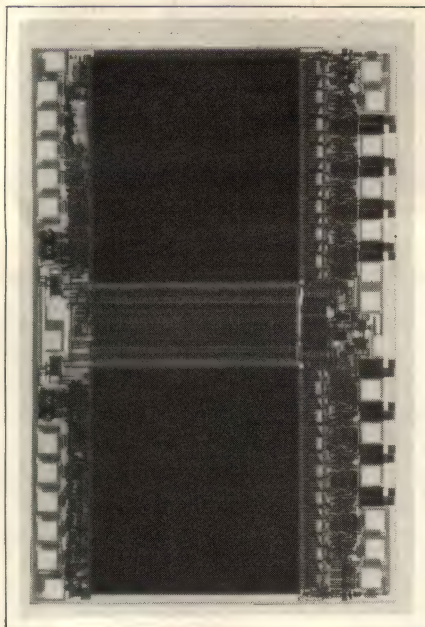


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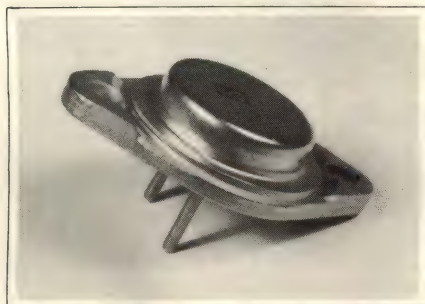


EPROM

The 27128B-110V05 128k-bit EPROM is a reduced-geometry version using the company's HMOS II-E technology. It has 110-nsec access time, which represents a 40-nsec improvement over the manufacturer's 27128A-1 device. The higher speed eliminates wait states when you use the device with advanced μ Ps. The memory fits the standard JEDEC-approved 28-pin site. In a windowed ceramic DIP, \$9.80 (1000).

Intel Corp, Literature Dept W-278, 3065 Bowers Ave, Santa Clara, CA 95051. Phone (408) 987-8080.

Circle No 427



REGULATOR ICs

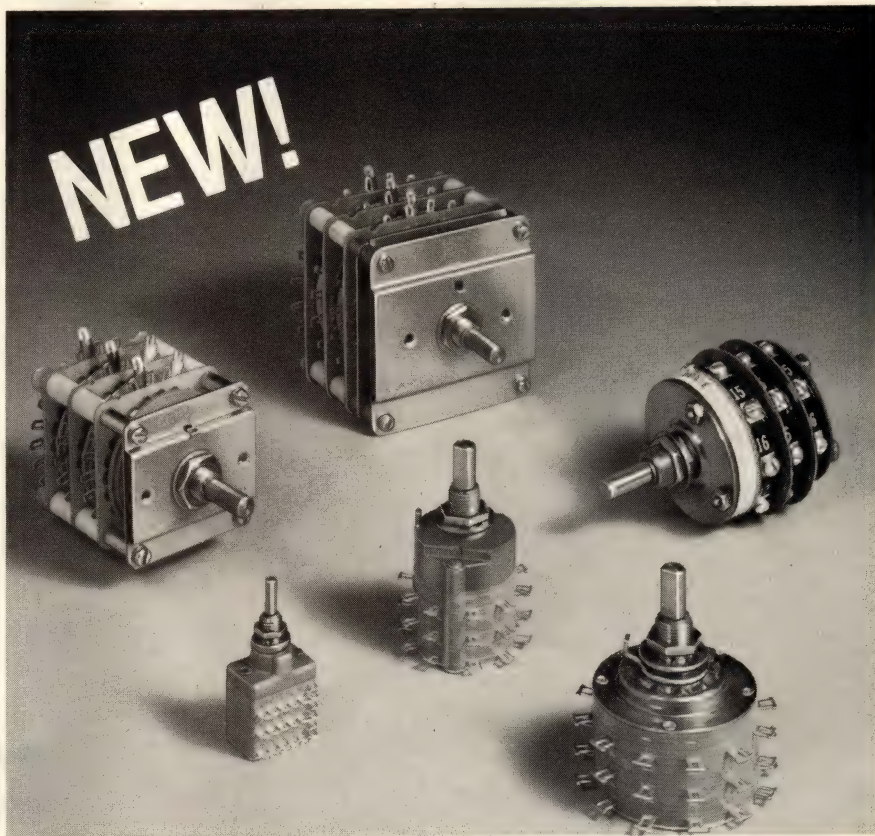
The CJSE-R Series voltage regulators add additional pinout combinations to the company's line of 3-terminal, fixed-output linear voltage

regulators. In this series, V_{IN} connects to the case, V_{OUT} is pin 2, and return is pin 1. Features include positive or negative input, output voltages from ± 2 to $\pm 50V$, output current of 3 and 5A, and knee current and short-circuit protection designed to customer specifications. Thermal resistance is $1^\circ C/W$ typical, and V_{OUT} tolerance is $<1\%$ at

$25^\circ C$ and $<3\%$ from -55 to $+125^\circ C$. These devices exhibit no oscillations and are designed for radiation-resistant applications. \$45 (50). Delivery, eight to 12 weeks ARO.

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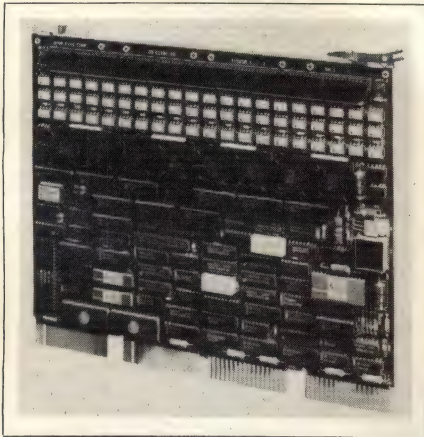


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CIRCLE NO 180

NEW PRODUCTS: COMPUTER-SYSTEM SUBASSEMBLIES



INTERFACE MODULE

Using buffered inputs and DMA outputs, this DHV11-compatible, 16-channel asynchronous communication interface module, the D5-CI101-16, has a transfer rate of 54,000 cps. Each of the 16 full-duplex communication channels can control remote modem communication and furnishes selectable baud rates of 50 to 38.4k baud. Transparent to DEC software, the module

interfaces via either RS-232C or RS-423 connectors to modems or terminals. Approximately \$900 (OEM qty).

Dyna Five Corp, 12040 Western Ave, Garden Grove, CA 92641. Phone (714) 898-6886.

Circle No 429

IMAGE PROCESSOR

The AT-428 is a plug-in board for capture, display, and storage of video images on an IBM PC/AT. The board can generate RGB pseudocolor display output. The processor digitizes RS-170 and CCIR analog video signals in real time, and it can store as many as four 384×512×8-bit images in its onboard video memory. Using the 8-bit-deep frame store, you can assign 256 gray levels to each video image. The processor is mapped in the system's memory, so the host PC/AT can use DMA to transfer

stored images from the board to the PC/AT. Three RGB output look-up tables provide pixel data translation to the digital video information, for such functions as linearizing, thresholding, and gamma correction. Three D/A converters provide three separate pseudocolor outputs for color or monochrome display monitors. For true-color, 24-bit video image digitizing and display, you can link three of the boards together. \$2995.

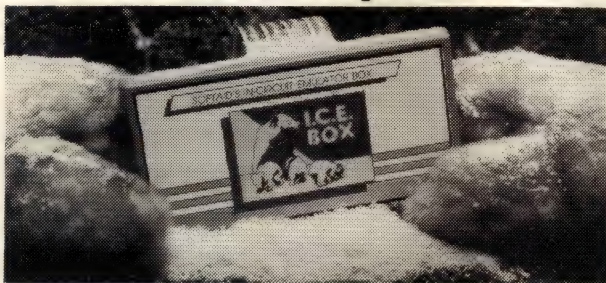
Datacube Inc, 4 Dearborn Rd, Peabody, MA 01960. Phone (617) 535-6644.

Circle No 430

PC SIGNAL PROCESSOR

The Model 10 digital signal processor is a coprocessor board for the IBM PC/XT and compatibles. It features Texas Instruments' 16/32-bit TMS32010 digital signal processor, which is a fixed-point, high-speed

True Full Speed Emulation Now Available With Overlay Ram!



The I.C.E.BOX is a small, compact emulator, easy to move and use. Though it costs about the same as other handheld emulators, it is the only portable unit that offers true full speed emulation with hardware breakpoints. The I.C.E.BOX has 65,535 hardware breakpoints that can be set anywhere in memory—even in ROM! Optional ICEpack software supports symbolic debugging and includes ICEBASIC, a BASIC language designed especially for use with the I.C.E.BOX. Use it to create custom automation packages for production test and service. And now the REFRIGERATOR is available to tackle your toughest debugging jobs. The REFRIGERATOR is an I.C.E.BOX with the bonus of 16K of overlay RAM. The REFRIGERATOR can download code into your target system's ROM address space!

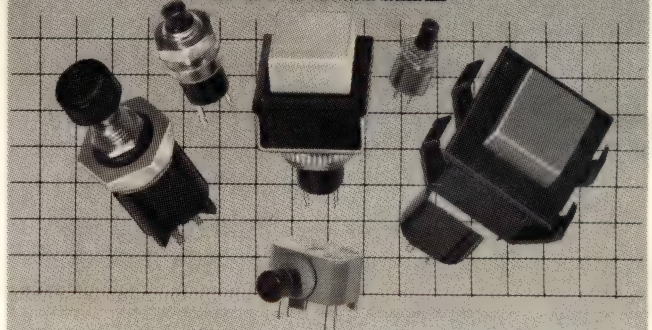
- Built-in RAM and ROM tests • Breakpoints can be set in ROM or RAM • Breakpoints and emulation run at full target system speed • Binary or hex programs can be downloaded over RS232 • Assembles/disassembles code • Traces execution • Traces while skipping subroutines • Compares and alters memory, I/O and registers.

The I.C.E.BOX is available for the Z80, 8085, and NSC800 processors for \$600.00. The REFRIGERATOR (Z80 only) is \$900.00. Contact Softaid, Inc., 8930 Route 108, Columbia, MD 21045 — (301) 964-8455. We accept Visa, Mastercard, checks and COD.



CIRCLE NO 181

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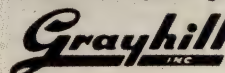
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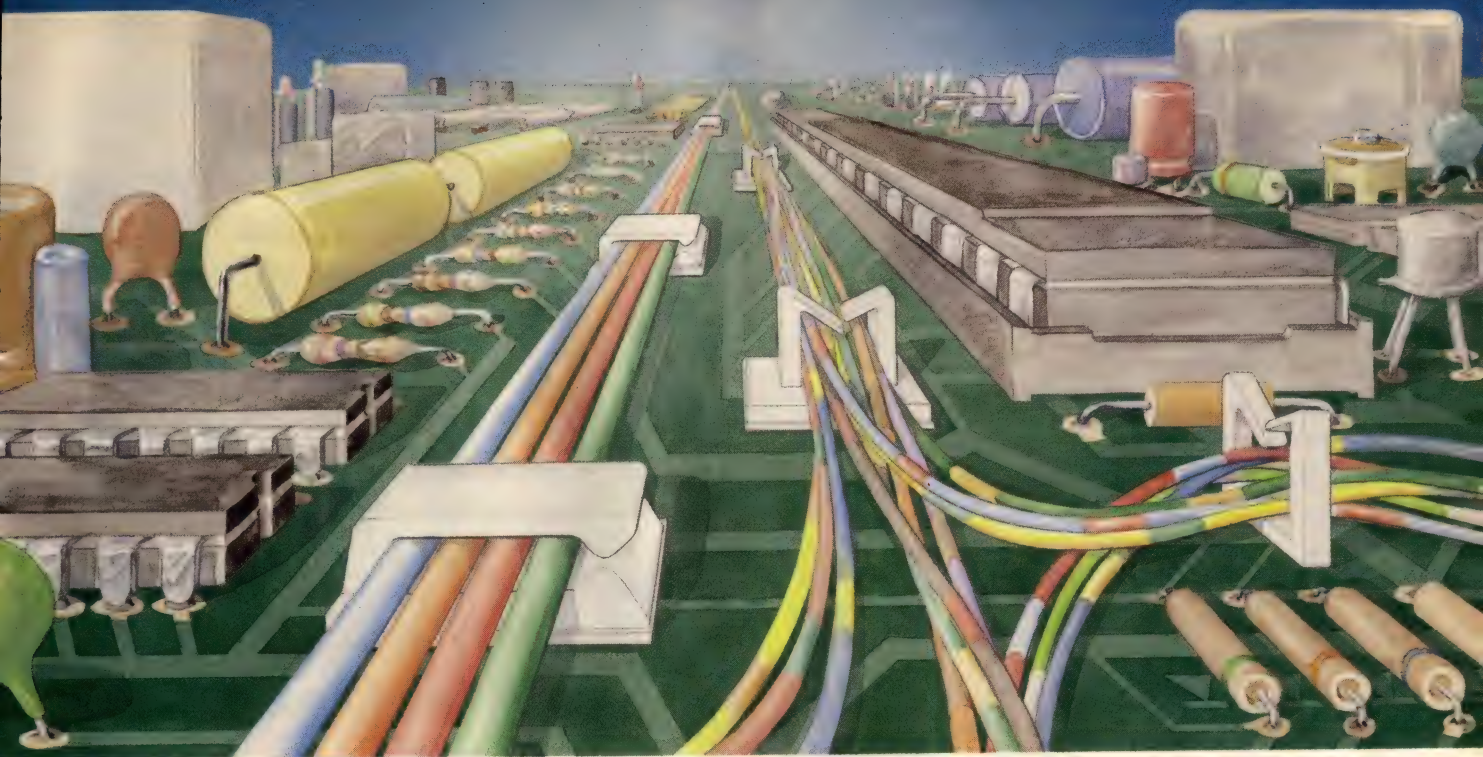
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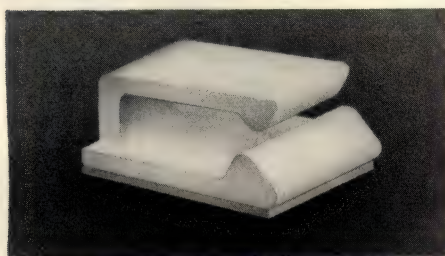
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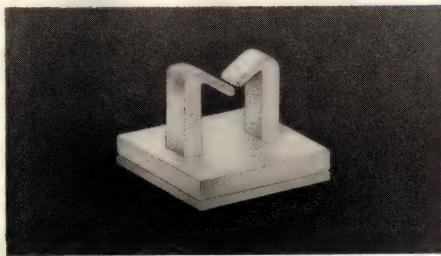
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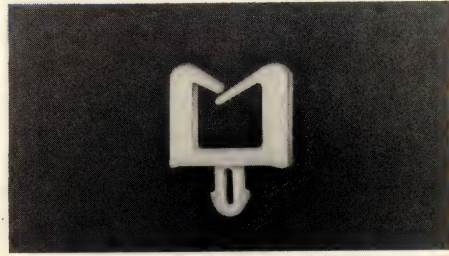
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CIRCLE NO 184

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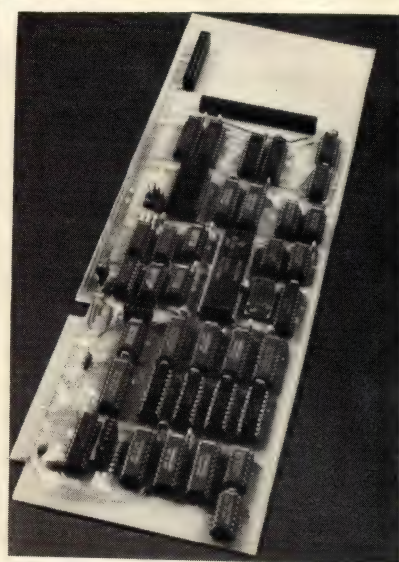


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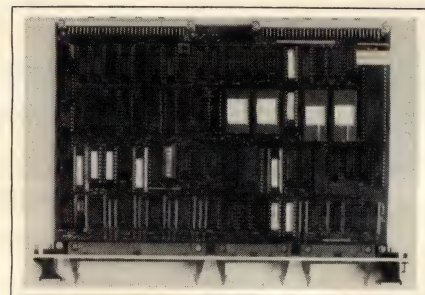
COMPUTER-SYSTEM SUBASSEMBLIES



μP. Sample execution times are 400 nsec for multiply-accumulate and 60 msec for 1024-point complex FFTs. Three 16-bit timers provide sampling rates from 0.001 Hz to 200 kHz. The coprocessor has a 2-way 16-bit register for communications between the TMS32010 and the PC's CPU, and it has mutual-interrupt capabilities. An external I/O bus connector permits the addition of special-purpose boards. Bundled software includes a debugger, in-line assembler, disassembler, signal-display software, and applications examples. \$750.

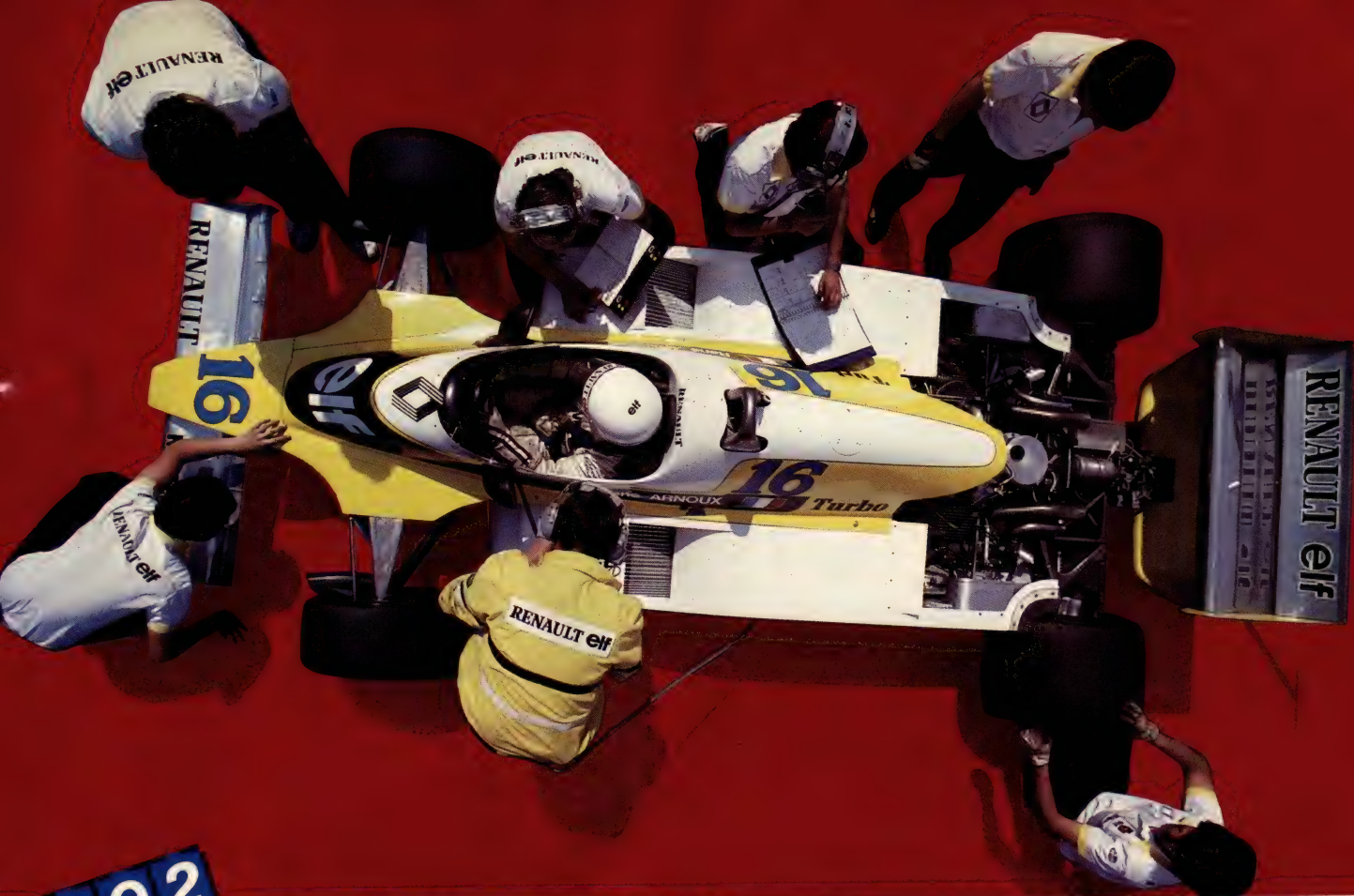
Dalanco Spry, 2900 Connecticut Ave NW, Suite 241, Washington, DC 20008. Phone (202) 232-7999.

Circle No 431



MEMORY CONTROLLER

The GMSV09 mass-storage controller offers SMD (storage module drive) and QIC-02 interfaces for VME Bus systems. You can order



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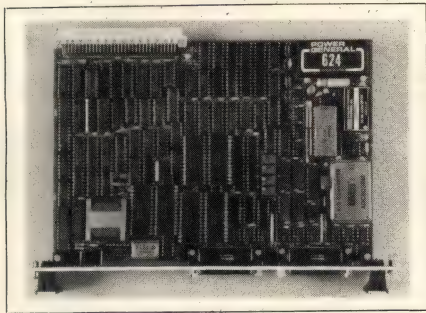
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COMPUTER-SYSTEM SUBASSEMBLIES

the controller with both interfaces and transfer rates of 10M bps or 16M bps; SMD-interface-only versions are also available. Versions with the QIC-02 interface can run as many as four streaming-tape drives. You can read both soft- and hard-sectored track formats, and sector length is software programmable. The controller has user-programmable drive characteristics for SMD/CMD/MMD/LMD interfaces, and it meets CDC specifications. It also has its own controller and drive diagnostics. \$2495 to \$3295.

General Micro Systems Inc.
4740 Brooks St, Montclair, CA 91763. Phone (714) 625-5475.

Circle No 432



VME BUS DSP BOARD

The ICS-100 is a VME Bus multi-channel finite-impulse-response (FIR) filter board with four simultaneously sampled analog inputs and four analog outputs. A 12-bit A/D converter sequentially digitizes the samples. The sampling rate can be as high as 500 kHz. Digitized input signals are buffered in a FIFO for input to a VME Bus host. The 16-bit FIR-filter software operates on as many as four real or two complex inputs. The filter features programmable filter lengths from 4 to 255 taps per channel; two switchable coefficient-memory blocks; and a computation rate of approximately 100 nsec per tap. The ICS-100 VB version does not include the analog input and output section. The processing circuits accept data from either the 12-bit A/D converter, or through a 16-bit host port; for the ICS-100 VB, it accepts data through

a 16-bit front-panel port. The output section comprises a 4-channel D/A converter and a 512-word FIFO to buffer the filter-output data for transfer to a VME Bus host. You can generate an interrupt on board after every filter output or after every n filter output, depending on the interrupt interval selected. User-developed software se-

lects the processing options by writing to the parameter and control registers, and then writes the filter coefficients into the coefficient memory. ICS-100V, \$3295.

Interactive Circuits & Systems Ltd., 3101 Hawthorne Rd, Ottawa, Ontario, Canada K1G 3U8. Phone (613) 521-0590.

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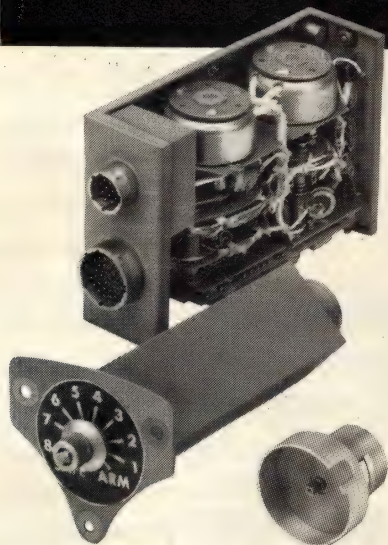
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CIRCLE NO 188

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COMPUTER-SYSTEM SUBASSEMBLIES

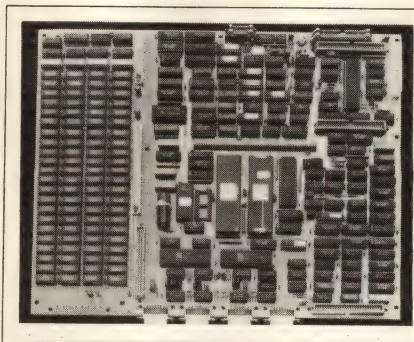


WINCHESTER DRIVE

The HP 97503B, a 20M-byte, 3½-in. Winchester disk drive, suits the industrial OEM market. Using forced-air cooling, the mechanism can continue to operate over the 0 to 60°C range even during drastic temperature changes. The drive specs a vibration tolerance of 8g nonoperational and 2g operational. An electronic feedback system measures servo information written between each data sector, allowing the drive to read and write data accurately even under less than ideal conditions. Projected MTBF is 40,000 hours. A controller is available for the IBM PC, PC/AT, PC/XT, and compatibles. Drive/controller combination, less than \$750 (OEM qty).

Hewlett-Packard Co., 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office.

CIRCLE NO 434



COMPUTER

The 712G is a single-board, System V-compatible subassembly containing a 68010 CPU (or two 32032s) and a no-wait-state RAM that provides error checking and correction. The 2M-byte onboard RAM is expand-

able to 4M bytes. The computer can run software supplied by the customer, or it can run the company's real-time, Unix/Xenix System V-compatible OS, RTIX. The board furnishes four RS-232C ports (expandable to 12), 5¼- and 8-in. floppy-disk interfaces, and two SCSI interfaces. A VME backplane is optional. The board is available in several configurations. A typical subassembly, including demand paging, battery-backed clock/calendar, automatic start and boot, and a socket for a floating-point processor, costs \$1890 (OEM qty).

Isotron Inc., 140 Sherman St, Fairfield, CT 06430. Phone (203) 255-7443. TLX 756436.

CIRCLE NO 435

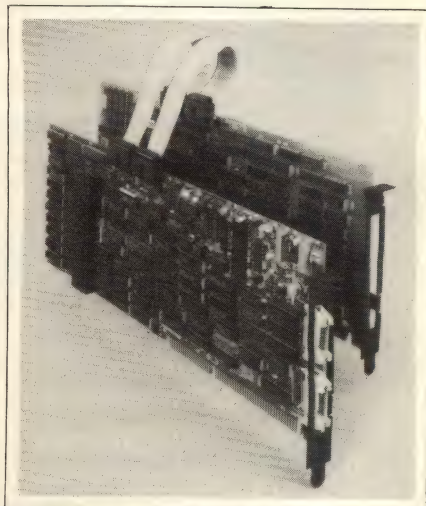


IMAGE PROCESSORS

The DT2851 high-resolution frame grabber digitizes, stores, processes in real time, and displays video images. The DT2858 auxiliary frame processor, a 16-bit pipelined processor, connects directly to the frame grabber over special I/O ports and can improve system performance. The auxiliary processor can compute a 3×3 convolution on a 512×512×16-bit image frame in 0.85 sec. The DT-Iris image-processing software implements processing algorithms on the DT hardware 250 times faster than the PC/AT alone, according to the manufacturer. Multiple synchronization

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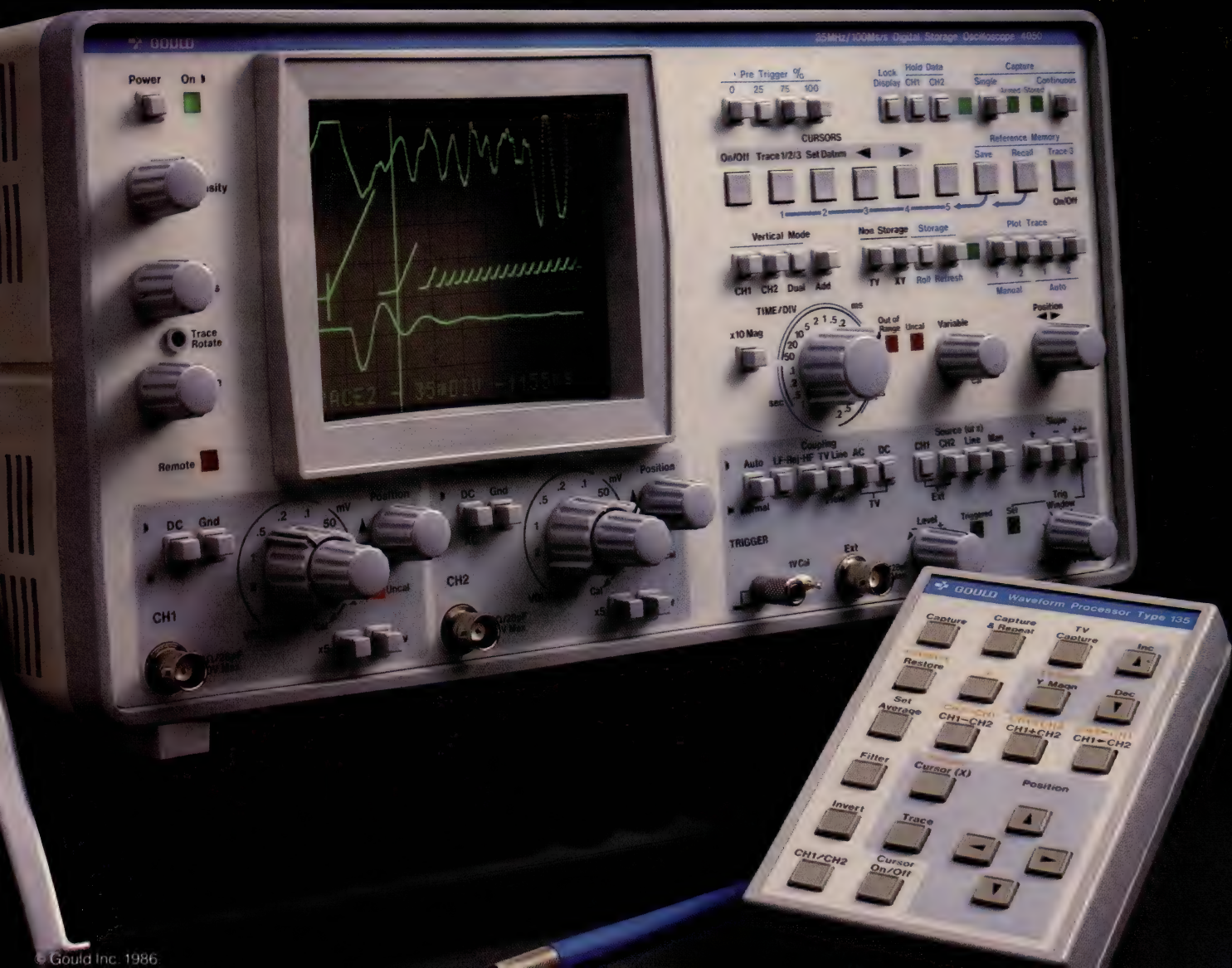
What's more, it has two independent cursor methods backed up by five reference memories. And you can even output to an HPGL compatible plotter for fully annotated multicolor hard copy.

But Gould doesn't stop here. Many other advanced features make the 4050 an excellent bench instrument. And with its onboard IEEE 488 interface, you can even automate your testing.

For more information or a demonstration, write Gould Inc., Recording Systems Division, 3631 Perkins Avenue, Cleveland, OH 44114. Or in the U.S. and Canada, call 1-800-447-4700, Operator 100.

CIRCLE NO 190

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Electronics



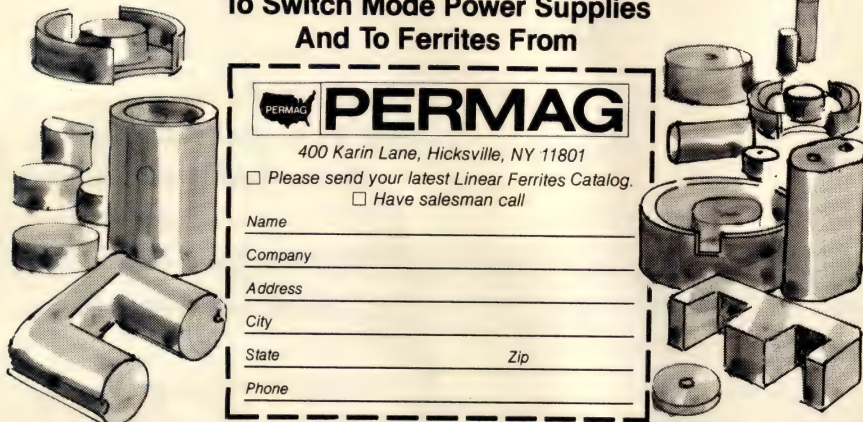
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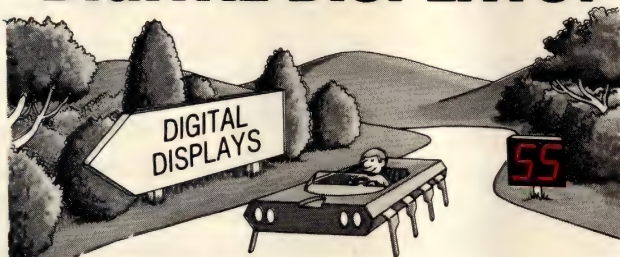
COMPUTER-SYSTEM SUBASSEMBLIES

inputs and outputs permit the board to use nonstandard and standard video sources, including all video cameras, VCRs, and slow-scan devices. Input signals are digitized into 512 horizontal lines, with 512 pixels each. The processor can merge, subtract, or offset frames by a constant value. AND, OR, and XOR logic operations are also possible. The memory architecture of the frame grabber features two 256k-byte memory buffers (enough on-board storage for two complete image frames). A RAM conversion table and a 16-bit ALU include 256-bit histograms, zoom, pan, scroll, and other arithmetic and logic operations. The 16-bit/pixel internal accuracy eliminates round-off errors in intermediate calculations. DT2851, \$2995; DT2858, \$1495; DT-Iris, \$995.

Data Translation Inc., 100 Locke Dr, Marlboro, MA 01752. Phone (617) 481-3700. TLX 951646.

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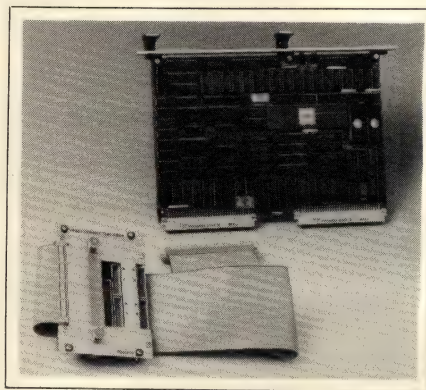


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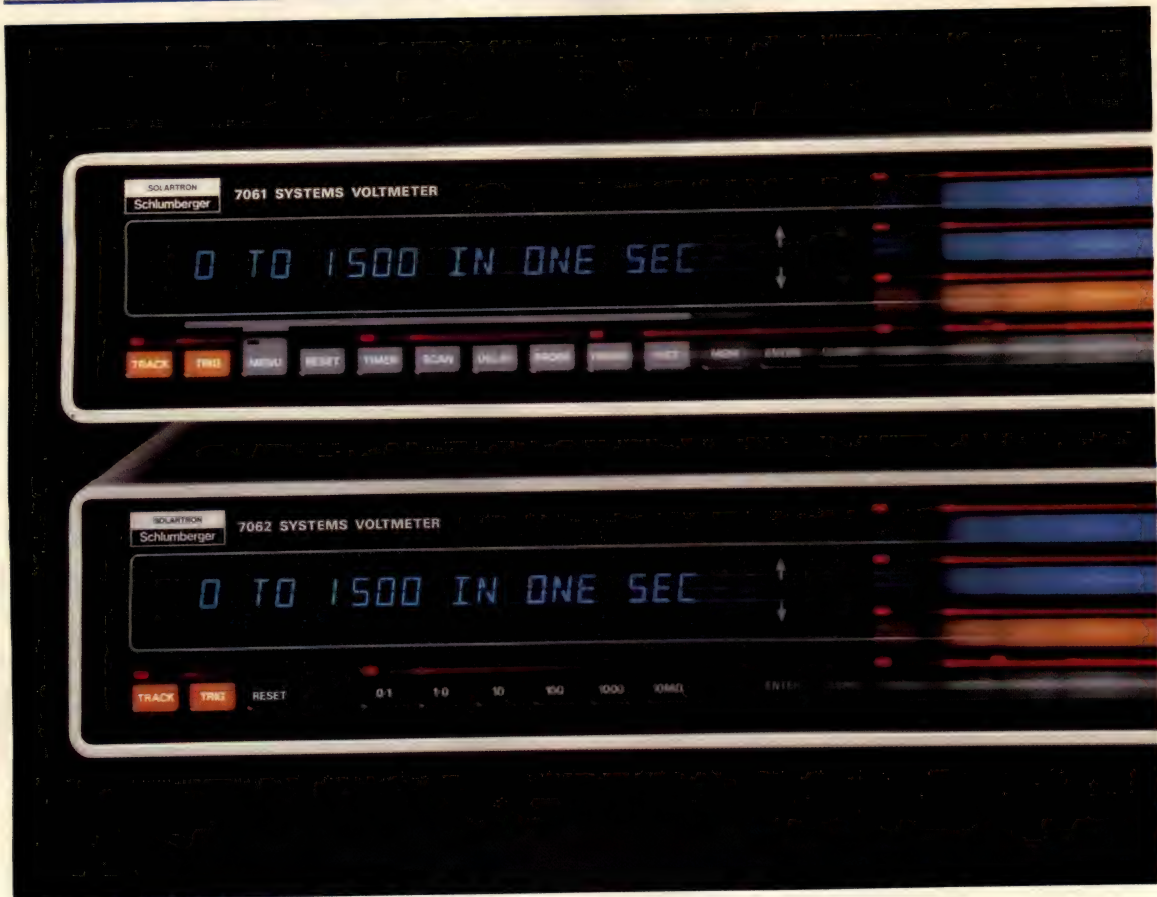
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DISK CONTROLLER

The VESDI-32, a disk controller for systems using the ESDI (enhanced small device interface) protocol, employs an MC68000 μ P and supports a maximum data-transfer rate of 1.2M bytes/sec when connected to 10M-bps drives. In addition, it has a 250k-byte cache, the parameters of which are software selectable. The disk controller performs single-command disk reads to multiple portions of the address space; contiguous or scatter/gather memory

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		<i>Management</i>		<i>Other</i>		<i>Management/Total Engineering</i>		<i>Other/Total Engineering</i>	
EDN	161,164	EDN	54,315	EDN	102,027	EDN	38,969	EDN	98,178
Electronic Design	151,029	Electronic Design	52,378	Electronic Design	94,658	Electronic Design	37,071	Electronic Design	90,687
EE Times	137,232	EE Times	47,135	EE Times	86,345	EE Times	34,807	EE Times	83,779
Electronic Products	122,892	Electronic Products	43,211	Electronic Products	76,336	Electronic Products	29,850	Electronic Products	72,425
Electronics	90,275	Electronics	36,365	Electronics	52,211	Electronics	23,264	Electronics	49,066
TOTAL	398,714	TOTAL	153,253	TOTAL	233,094	TOTAL	90,808	TOTAL	211,537
PRINCIPAL RESPONSIBILITY		PRINCIPAL JOB FUNCTION		PRINCIPAL JOB FUNCTION		PRODUCTS RECOMMENDED, SPECIFIED OR PURCHASED		PRODUCTS RECOMMENDED, SPECIFIED OR PURCHASED	
<i>Other/Design/Development Engineering</i>		<i>Total Engineering</i>		<i>Design/Development Engineering</i>		<i>Total Semiconductors, ICs, Hybrids</i>		<i>Semiconductors/Digital</i>	
EDN	84,855	EDN	141,440	EDN	119,874	EDN	109,141	EDN	114,162
Electronic Design	79,678	Electronic Design	131,523	Electronic Design	113,402	Electronic Design	103,975	Electronic Design	108,507
EE Times	76,679	EE Times	121,936	EE Times	109,204	EE Times	94,127	EE Times	97,304
Electronic Products	61,869	Electronic Products	105,288	Electronic Products	87,597	Electronic Products	86,736	Electronic Products	89,932
Electronics	40,772	Electronics	74,071	Electronics	60,684	Electronics	60,836	Electronics	62,676
TOTAL	164,747	TOTAL	312,985	TOTAL	235,666	TOTAL	201,659	TOTAL	204,939
PRODUCTS RECOMMENDED, SPECIFIED OR PURCHASED		PRODUCTS RECOMMENDED, SPECIFIED OR PURCHASED		PRODUCTS RECOMMENDED, SPECIFIED OR PURCHASED		PRODUCTS RECOMMENDED, SPECIFIED OR PURCHASED		PRODUCTS RECOMMENDED, SPECIFIED OR PURCHASED	
<i>Semiconductors/Analog</i>		<i>Modules</i>		<i>Microprocessor Components/Systems</i>		<i>Resistors/Capacitors</i>		<i>Pots/Relays/Switches</i>	
EDN	100,386	EDN	85,666	EDN	102,546	EDN	112,466	EDN	106,771
Electronic Design	94,284	Electronic Design	80,710	Electronic Design	99,016	Electronic Design	105,443	Electronic Design	98,244
EE Times	84,361	EE Times	71,921	EE Times	88,579	EE Times	94,232	EE Times	89,214
Electronic Products	80,608	Electronic Products	70,615	Electronic Products	78,439	Electronic Products	92,048	Electronic Products	88,358
Electronics	54,074	Electronics	45,646	Electronics	58,058	Electronics	58,513	Electronics	54,868
TOTAL	177,819	TOTAL	153,117	TOTAL	197,349	TOTAL	213,755	TOTAL	213,069
PRODUCTS RECOMMENDED, SPECIFIED OR PURCHASED		PRODUCTS RECOMMENDED, SPECIFIED OR PURCHASED		PRODUCTS RECOMMENDED, SPECIFIED OR PURCHASED		PRODUCTS RECOMMENDED, SPECIFIED OR PURCHASED		PRODUCTS RECOMMENDED, SPECIFIED OR PURCHASED	
<i>Interconnection Devices</i>		<i>Test & Measuring Equipment</i>		<i>Power Supplies</i>		<i>Mini/Micro Computers</i>		<i>Computer Peripherals</i>	
EDN	106,733	EDN	108,891	EDN	93,809	EDN	70,892	EDN	75,064
Electronic Design	98,754	Electronic Design	101,156	Electronic Design	88,205	Electronic Design	67,727	Electronic Design	72,405
EE Times	89,110	EE Times	89,968	EE Times	77,000	EE Times	62,925	EE Times	64,708
Electronic Products	88,891	Electronic Products	86,520	Electronic Products	78,926	Electronic Products	53,753	Electronic Products	57,362
Electronics	56,166	Electronics	59,385	Electronics	49,330	Electronics	41,683	Electronics	43,747
TOTAL	214,593	TOTAL	235,125	TOTAL	186,234	TOTAL	151,436	TOTAL	156,674
PRODUCTS RECOMMENDED, SPECIFIED OR PURCHASED		PRODUCTS RECOMMENDED, SPECIFIED OR PURCHASED		PRODUCTS RECOMMENDED, SPECIFIED OR PURCHASED		AGE: 25-54		PERSONAL INCOME	
<i>Readout Indicators/Display Devices</i>		<i>Total Components</i>		<i>Total Computer Products</i>				<i>Over \$35,000</i>	
EDN	81,462	EDN	146,910	EDN	103,423	EDN	131,661	EDN	96,941
Electronic Design	74,741	Electronic Design	137,125	Electronic Design	98,972	Electronic Design	124,327	Electronic Design	91,425
EE Times	67,358	EE Times	124,877	EE Times	89,696	EE Times	114,242	EE Times	83,374
Electronic Products	69,691	Electronic Products	113,616	Electronic Products	78,527	Electronic Products	99,531	Electronic Products	70,758
Electronics	41,325	Electronics	79,592	Electronics	59,786	Electronics	75,604	Electronics	55,858
TOTAL	158,909	TOTAL	313,314	TOTAL	219,642	TOTAL	317,195	TOTAL	231,289
NUMBER EMPLOYEES AT ADDRESS		NUMBER EMPLOYEES IN COMPANY		LENGTH OF TIME IN ELECTRONIC/COMPUTER INDUSTRY		READING HABITS		READING HABITS	
<i>250 +</i>		<i>250 +</i>		<i>11 + Years</i>		<i>Read Every Issue</i>		<i>Read More Than 75%</i>	
EDN	97,152	EDN	118,313	EDN	95,451	EDN	121,439	EDN	29,248
Electronic Design	88,671	Electronic Design	109,588	Electronic Design	89,542	Electronic Design	112,346	Electronic Design	26,678
EE Times	84,577	EE Times	103,070	EE Times	78,986	EE Times	110,619	EE Times	28,503
Electronic Products	67,655	Electronic Products	84,872	Electronic Products	73,860	Electronic Products	90,665	Electronic Products	23,478
Electronics	47,450	Electronics	61,511	Electronics	52,687	Electronics	70,121	Electronics	19,638
TOTAL	228,584	TOTAL	286,831	TOTAL	216,176	TOTAL	393,475	TOTAL	393,475

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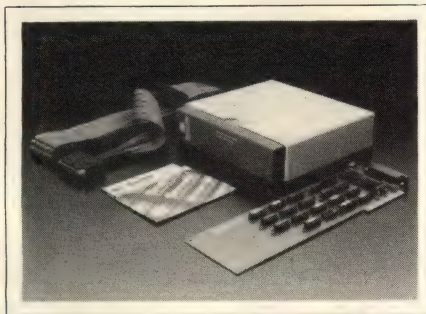
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COMPUTER-SYSTEM SUBASSEMBLIES

transfers; software-selectable, 16- or 32-bit DMA data transfers; and 24- or 32-bit addressing. The VME Bus-compatible unit controls a maximum of four ESDI drives with data rates to 20M bps. It resides on a 4-layer, dual-height pc board and operates over the 0 to 60°C range. \$2990.

Dual Systems Corp., 2530 San Pablo Ave, Berkeley, CA 94702. Phone (415) 549-3854.

Circle No 437



CONTROLLER CARD

Bundled with three software utilities for micro-to-mainframe communications, hard-disk backup, and tape-drive diagnostics, Overdrive Tools is a 1/2-in. tape-controller card for the IBM PC, PC/AT, or compatibles. Tie (tape import/export), the first utility, allows users to download mainframe files to PCs, converting the data from EBCDIC to ASCII (or vice versa). It also creates variable files for using mainframe data in conjunction with PC software programs like dBase, Lotus 1-2-3, and Symphony. The system automatically adjusts tape speed. Tie transfers data at 3.3M bytes per minute. Asp (archival storage protector), the second utility, is for backing up files. You can use TTU (tape test utility) for on-site diagnostics. With TTU, you can test the tape-transport unit, controller card, and cable assembly. \$486 (OEM qty).

Emerald Systems Corp., 4757 Morena Blvd, San Diego, CA 92117. Phone (619) 270-1994.

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CIRCLE NO 195

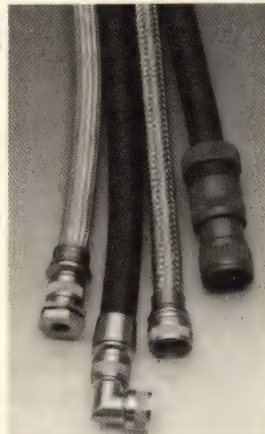
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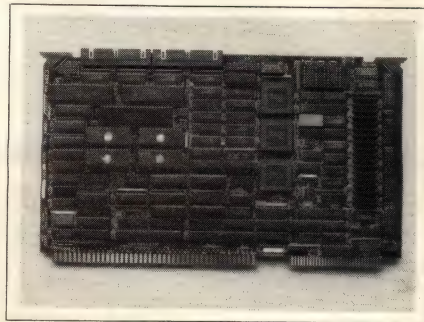
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**TURN TO
PAGE 370**

COMPUTER-SYSTEM SUBASSEMBLIES



MULTIBUS COMPUTER

The COM-4, a Multibus single-board computer, has two 10-MHz user-programmable DMA controllers that provide each of the four on-board serial ports with two channels of DMA. These channels transmit and receive blocks of data to and from onboard RAM, providing full-duplex operation at maximum memory speed. With the onboard dual-ported memory, you can access data from either the local bus or the Multibus. This computer runs with no wait states at 10 MHz using the 68000 or 68010 μ P. No-wait-state RAM with hidden refresh uses <0.5% of the local processor's bandwidth for refresh activities. Four 28-pin sockets for nonvolatile memory provide as many as 256k bytes of user-programmable space for on-board communication routines, reference data, or an onboard operating system. The company provides drivers and their support with Hunter & Ready's VRTX real-time executive. Other software available includes Alcyon's Regulus for Unix-like real-time operation, Probug for software debugging (including editor/assembler), and Comus I/O support program for serial communications. With 128k-byte memory and two DMA controllers, \$1195.

SBE Inc., 2400 Bisso Lane, Concord, CA 94520. Phone (800) 221-6458; in CA, (800) 328-9900. TWX 910-366-2116.

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COMM SYSTEMS

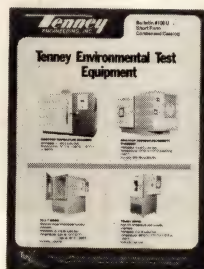
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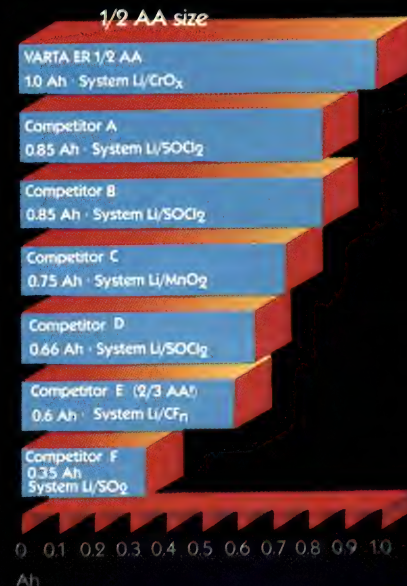
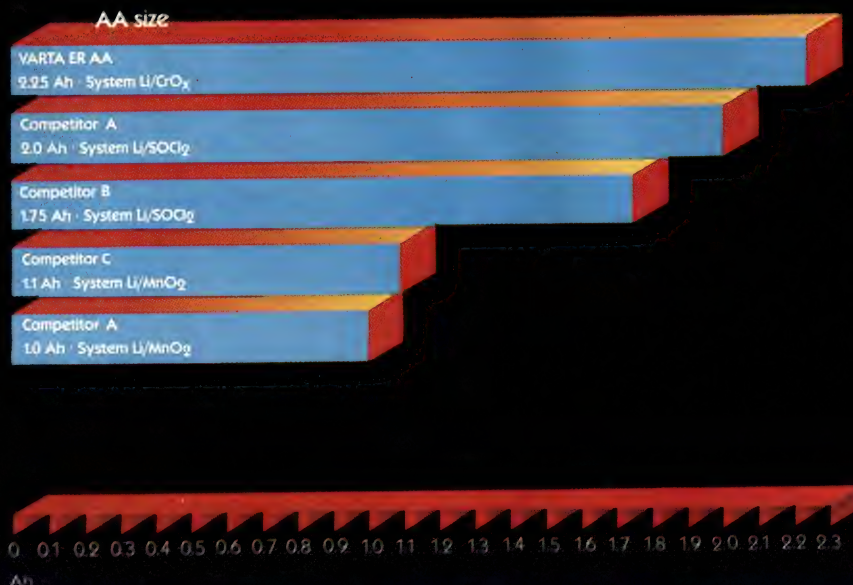
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COMPUTER-SYSTEM SUBASSEMBLIES

34/36/38 (S/3X) and remote IBM PCs and compatibles. It integrates 5251-12 terminal emulation, a synchronous modem, and an autodialer on one pc board. The system comes in two models. The Mate-24 has a 2400-bps, 201C-compatible modem and suits dial-up operations. Mate-48 includes a 4800-bps 208A/B-compatible modem. You can use the

4800-baud version in either dial-up or leased-line applications. Both models have an automatic dialer that you can either control from the PC's keyboard, or totally automate. To install these devices, you plug the phone line into the board, and plug the board into any full-length expansion slot in the PC. Using the menu, you can define the parame-

ters for terminal and printer operations, modem options, and autodial functions. You can switch back and forth between terminal emulation and PC-DOS without interrupting communications. With 2400-bps and 4800-bps modems, \$1395 and \$1995, respectively.

Emerald Technology Group Inc., 1601 116th NE, Suite 102, Bellevue, WA 98004. Phone (206) 462-8200.

Circle No 440



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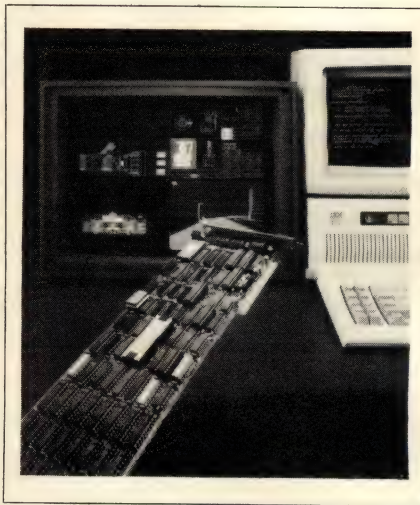
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DATTEL

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CONTROLLER

The Artist 1 Plus is a 64-MHz controller for IBM PCs, PC/ATs, and compatible computers. It produces flicker-free images at a noninterlaced resolution of 1024×768 pixels; with a factory-configured option, it can display fast-refresh, 1024×1024-pixel interlaced images. The controller incorporates a NEC 7220A processor, which manages the graphic functions. Four memory planes store images, which can contain as many as 16 colors (from a palette of 4096). The controller's hardware can access all four planes simultaneously, increasing redraw and regeneration speeds. In addition, this controller is software compatible with all the manufacturer's boards. \$2795.

Control Systems Inc., 2855 Anthony Lane, Minneapolis, MN 55418. Phone (612) 789-2421.

Circle No 441

Anritsu Presents Spectrum Analysis That's Simply Unforgettable



MS710C Spectrum Analyzer

No more writing down results. No more sketching waveforms on paper. No more grease pencil graphics on the CRT grid. Why?

Because Anritsu's new MS710-series Spectrum Analyzers actually *remember* display screens for you — up to nine of them, in fact. Each one complete with waveforms and comprehensive alphanumeric information such as frequency, level, etc. Each one ready for recall to the CRT at the push of a button. Check and recheck, contrast one with another, even compare

the current real-time waveform to a standard in memory. It's like having a file of waveform information always at your fingertips. Frequency range is wide, too; for instance, our new MS710C covers the range from 10kHz to 23GHz (or up to 140GHz with an external mixer). It offers signal search functions, along with an ergonomic front panel that puts every control right where it's needed. A special display lists key functions right on the screen: it's virtually a built-in operator's manual!

Can't get the MS710C out of your mind? Contact Anritsu for further details.

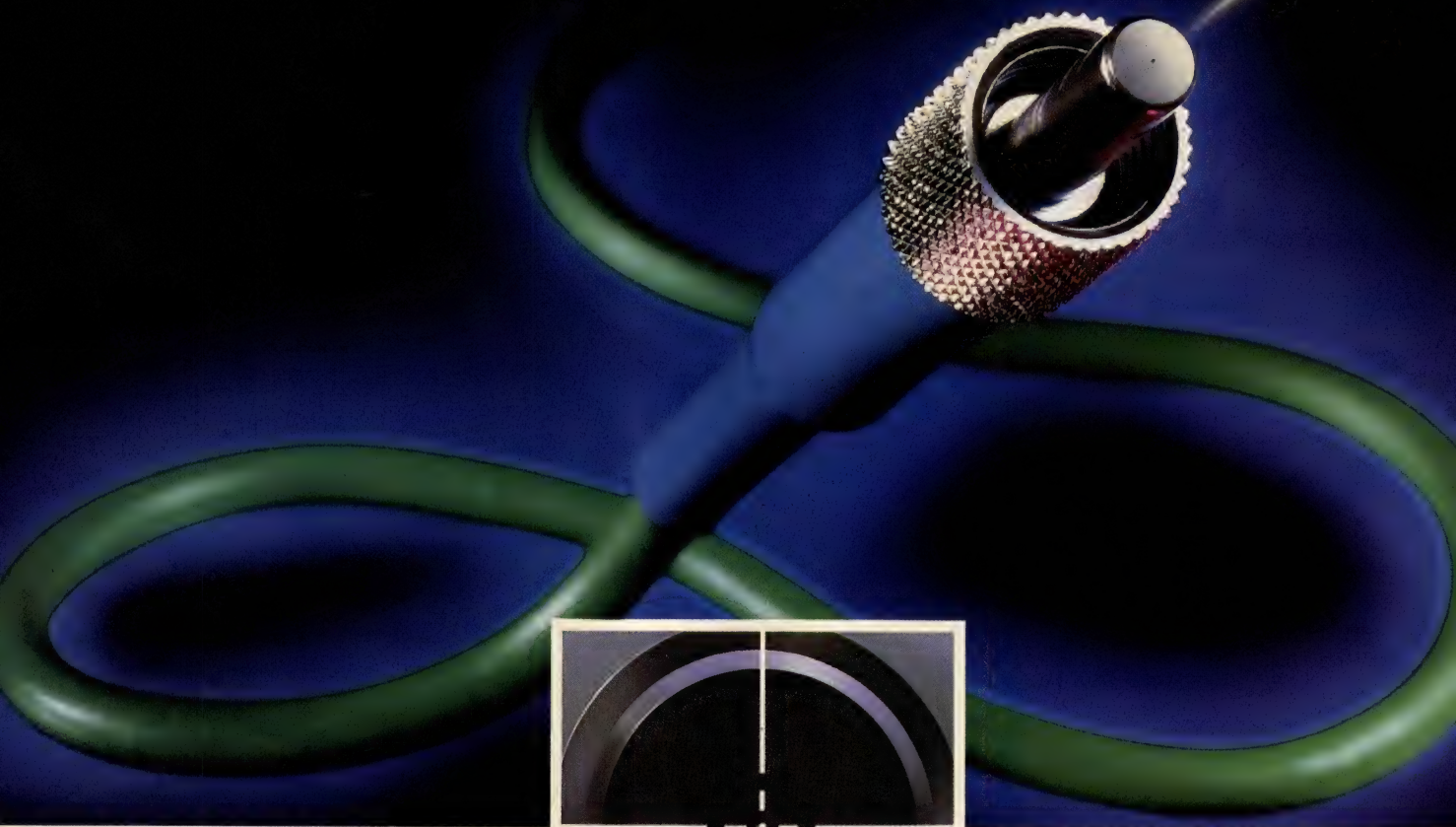
Spectrum Analyzer	Frequency Range	Frequency Stability (6.5GHz)	Frequency Range with External Mixer
MS710C	10kHz~30MHz, 100kHz~23GHz	30kHz	18~140GHz
MS710D	100kHz~23GHz	1MHz	18~140GHz
MS710E	100kHz~23GHz	30kHz	—
MS710F	100kHz~23GHz	1MHz	—

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Data I/O, Box 97046, Redmond, WA 98073. Phone (800) 426-1045; in WA, (206) 881-6444. TLX 152167.

Circle No 386

the network; to generate user-definable data frames for testing other nodes; and to create and measure network loading. The analyzer can determine network utilization by determining the distribution of the size of the frames. The instrument features softkey-guided programming that you can use to create your own applications. You can analyze LANs at distant locations by remote control using another HP 4971S over a standard RS-232C link. \$30,000. Delivery, eight weeks ARO.

Hewlett Packard Co, 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office.

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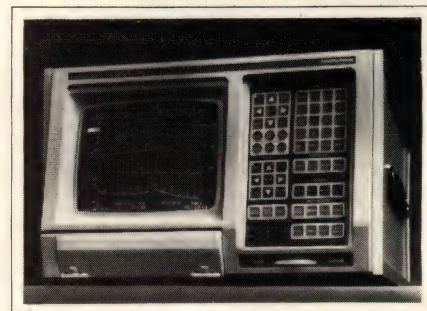
ETHERNET ANALYZER

The Lanalyzer EX 5000E hardware/software package enables an IBM PC to monitor the activity of an Ethernet (v 1.0 and v 2.0) local-area network. The unit can capture as much as 700k bytes of data independently of such protocols as TCP/IP, DECNet, XNS, and ISO. The device displays real-time data as bar graphs and can time-stamp events with 10- μ sec resolution. The package includes an add-in board for the PC and software to operate it. Lanalyzer EX 5000 E, \$9500;

Compaq Portable 286, \$19,500.

Excelan Inc, 2180 Fortune Dr, San Jose, CA 95131. Phone (408) 434-2226.

Circle No 388



FFT ANALYZER

The SD380 FFT signal analyzer now has four additional options. The 5 Opt converts the SD380's narrowband spectrum analysis into 3-decade, $\frac{1}{3}$ -, and single-octave displays. The 6 Opt (signature ratio adapter) accepts a tachometer rpm input. A 7 Opt (signal source) provides sine, swept-sine, broadband-noise, pseudorandom, burst-random, and zoom-limited-random output with programmable-level control to 40 kHz. An 8 Opt (data storage) is a built-in $3\frac{1}{2}$ -in., 728k-byte floppy disk for nonvolatile data storage of front-panel setups, time data, processed data, and waterfall files. The new features include inte-



LAN ANALYZER

The HP 4971S LAN analyzer tests IEEE 802.3 or Ethernet LANs. The device allows you to monitor, capture, and analyze data frames in

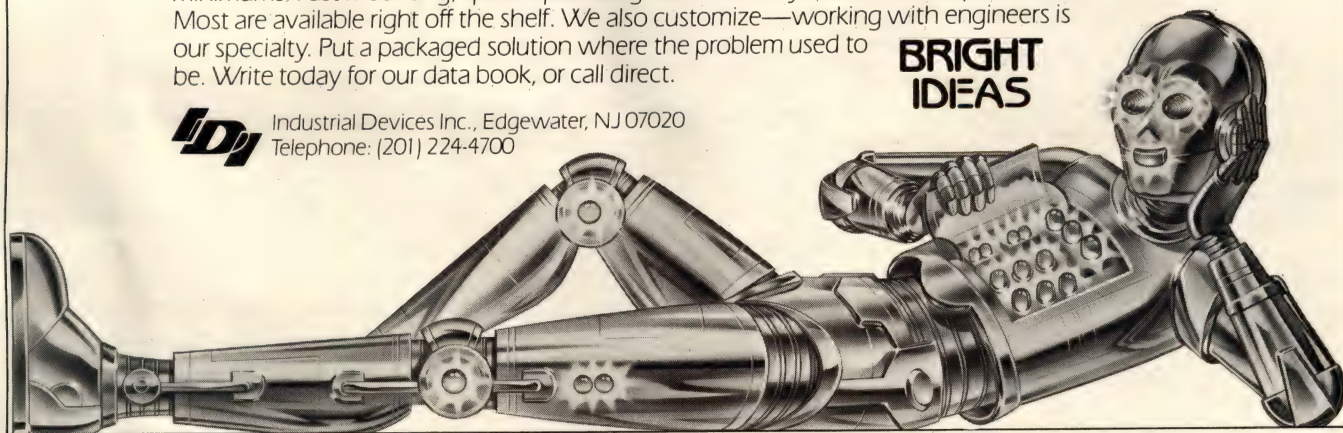
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ilies. It compares the logic states of an IC under test with those of a good reference IC. If all logic states are equal, a "good" indicator lights. If not, an LED lights for each bad pin. The device features pushbuttons for standard configurations for ground and V_{CC} for 14-, 16-, 18-, and 20-pin TTL ICs. The tester provides switches for nonstandard ground/ V_{CC} pin configuration. When used as a logic monitor, the device indicates the logic state of each IC pin. \$395.

B&K Precision, Dynacan Corp, 6460 W Cortland St, Chicago, IL 60635. Phone (312) 889-9087.

Circle No 391



RACK INSTRUMENTS

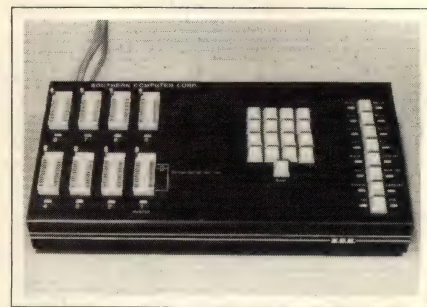
Each module of the Model 2324-R rack-mounted instrument system is a complete instrument that you can use separately. The system comprises a 2-MHz function generator; a 200-MHz counter/timer; a 10-MHz miniature oscilloscope; a 3½-digit, 0.1% accurate DMM; a bench rack system; and an ac power adapter. \$1291.

OK Industries Inc., 3455 Conner St, Bronx, NY 10475. Phone (212) 994-6600. TLX 125091.

Circle No 390

IC TESTER

The handheld Model 550 functions as either an IC-comparator tester for most 54- and 74-series 14-, 16-, 18-, and 20-pin TTL devices or as a logic monitor for 14-, 16-, 18-, and 20-pin 5V ICs. The instrument provides in-circuit testing of most standard TTL, Schottky, low-power Schottky, advanced low-power Schottky, high-speed, and Fast fam-



EPROM PROGRAMMER

The SCC-512A 8-device gang programmer has an optional 256k-byte memory buffer. The unit will program such devices as 27512 EPROMS and EEPROMS using the manufacturer's fast programming algorithms. The basic unit comes equipped with a keypad, an RS-232C port, eight zero-insertion-force sockets, and 16k bytes of memory. You select via a menu the correct settings for programming a particular device. The unit requires no personality modules, has surge protection and cold-socket start-up,



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Model 520/A

The Model 520/A is micro-processor based and is compatible with IEEE-488, (GP-IP).

The height is only 3½ inches, features current mode outputs from 10 nanoamperes (nA) to 110 milliamperes (mA), in 2 ranges, with extraordinary compliance of 100 Vdc. Even with this power, ideal for transducer instrument testing (4-20 and 10-50 mA), the accuracy is $\pm 0.005\%$!

The voltage mode has 3 ranges with outputs from 100 nV to 110 Vdc and optional to 1100 Vdc. Compliance current is 100 mA. The one year accuracy is $\pm 0.002\%$.

All ranges and both modes resolve to 1 ppm. A crowbar zero provides a reference for this essential value.

Availability: 60 days.

Price: \$2,750. 1000V option \$895.

Engineering Contact: **Bob Ross**

Tel: (617) 268-9696

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1000 Volt AC Amplifier



Model 4200

Very low cost AC voltage amplifier with a fixed gain of 100. Can be used to extend the output range of the EDC Model 4500, 100 Vac Calibrator, or used with AC voltage calibrators of most other manufacturers.

Specifically designed to use for the calibration of digital multimeters, digital and analog meters.

Range: 100 V to 1100 Vac, rms

Input Voltage: 10 Vac, rms

Fixed Gain: 100

Gain Accuracy: 0.05%

Frequency Band: 40 Hz to 30 kHz

Distortion: 0.2% of setting

Dimensions: 7.0H x 19.0W x 13.8D inches

Weight: 40 lbs.

Price: \$995

Availability: 60 days ARO

Engineering Contact: **Bob Ross**

Tel: (617) 268-9696

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Tel: (617) 268-9696

TLX: 951596 (ELECDEVCO BSN)

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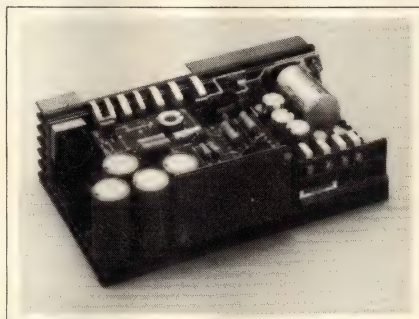
CIRCLE NO 4

INSTRUMENTATION & POWER SOURCES

incorporates voltage sensing circuitry for device protection, and can print labels. \$1195.

Southern Computer Corp., 3684 Clearview Ave, Atlanta, GA 30340. Phone (404) 455-8018. TLX 317867.

Circle No 392



500W SWITCHER

The GX500 has a power density of 3.6W/in.³ and offers five outputs: two high-power auxiliaries, two medium-power auxiliaries, and a primary output of 5V at 75A. The standard configurations have the high-power auxiliary outputs at $\pm 12V$ or $\pm 15V$ at 15A each. The low-power auxiliary outputs are 24V and -5V in standard units; you can select values between 2 and 48V. The device features adjustable auxiliary outputs, an input EMI filter, an ac fan output, an ac power-fail indicator, and remote sense for primary output. The unit complies with UL, CSA, and VDE safety requirements. \$485 (100).

Summit Electronics Inc., 855 E Collins Blvd, Richardson, TX 75081. Phone (214) 231-1456.

Circle No 393

CRT OSCILLOGRAPH

The Model 5F15 fiber-optic CRT recording oscillograph provides sharp traces with no overshoot or ringing. The device has a frequency response as high as 10 kHz. Its standard features include printed grid lines; five interval-timing lines; trace numbering; nine integral amplifiers; front-panel trace monitoring; automatic record-length; and edge annotation of date, number,



paper speed, and timing interval. The IEEE-488 control is optional. From \$14.35.

Soltec Corp., 11684 Pendleton St, Sun Valley, CA 91352. Phone (800) 423-2344; in CA, (818) 767-0044. TLX 4943094.

Circle No 394



DC/DC CONVERTERS

The LPS Series of dc/dc converters consists of five models providing 5, 12, 15, ± 12 , and $\pm 15V$ dc output at 15W. The devices come in 1.6x2x0.46-in. packages. All models maintain 85% efficiency over their 3:1 input-voltage range of 20 to 60V dc (48V dc nom). Power density is 10.2W/in.³ without external heat sinking or forced-air cooling. Key specifications include $\pm 0.5\%$ max line regulation; $\pm 0.5\%$ max load regulation for single-output models; and $\pm 1.0\%$ max load regulation for dual-output models. Single-output models, \$66.50; dual-output models, \$69.30 (100).

Computer Products, 7 Elkins St, South Boston, MA 02127. Phone (617) 268-1170. TWX 710-339-0855.

Circle No 395

TO DEVELOP A SELECTION THIS WIDE WE HAD TO BE NARROW-MINDED.

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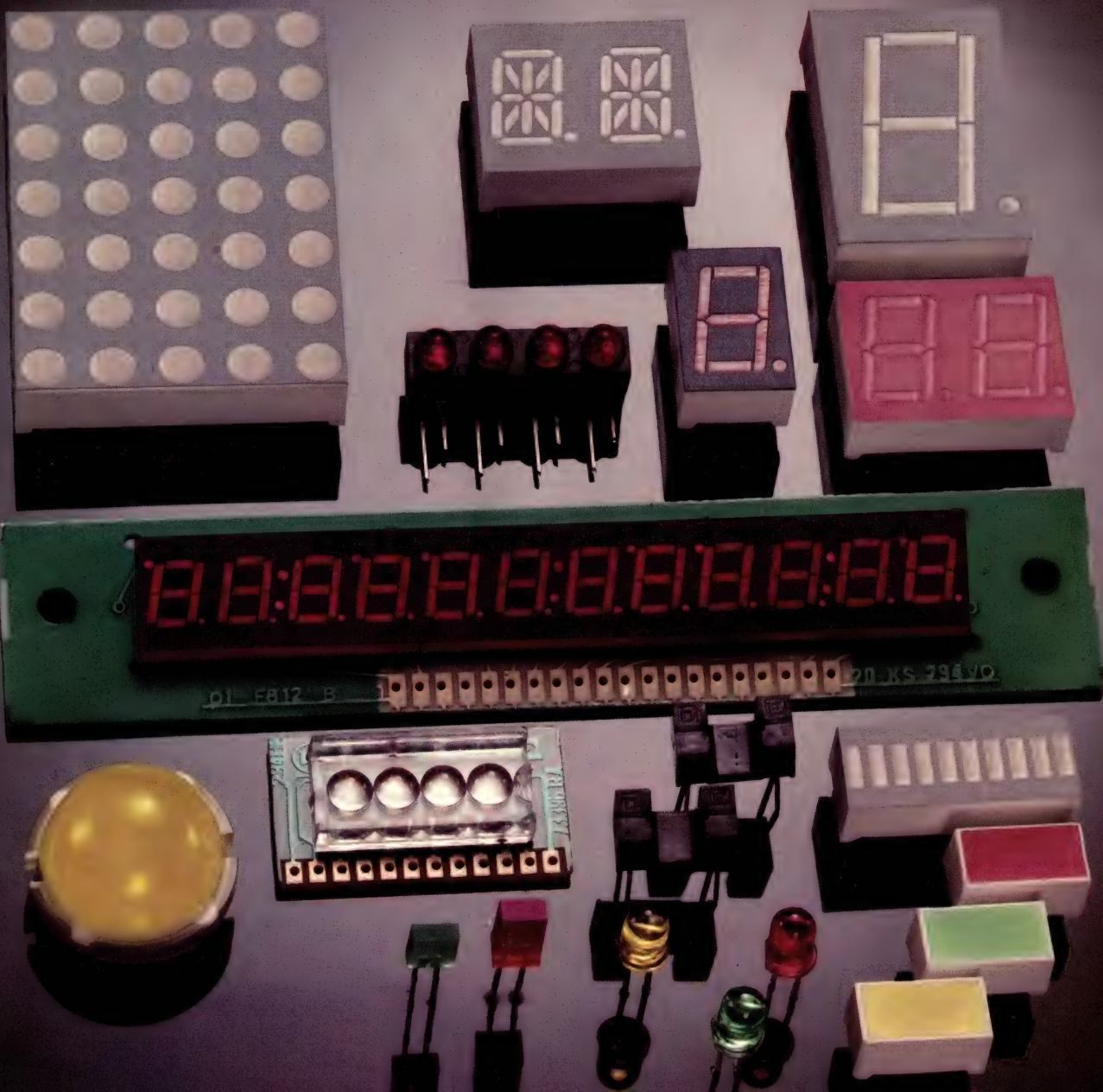
Our single-mindedness has also been responsible for helping us put together our fully automated offshore manufacturing facilities for higher reliability, increased design flexibility and turnaround times averaging 6 weeks.

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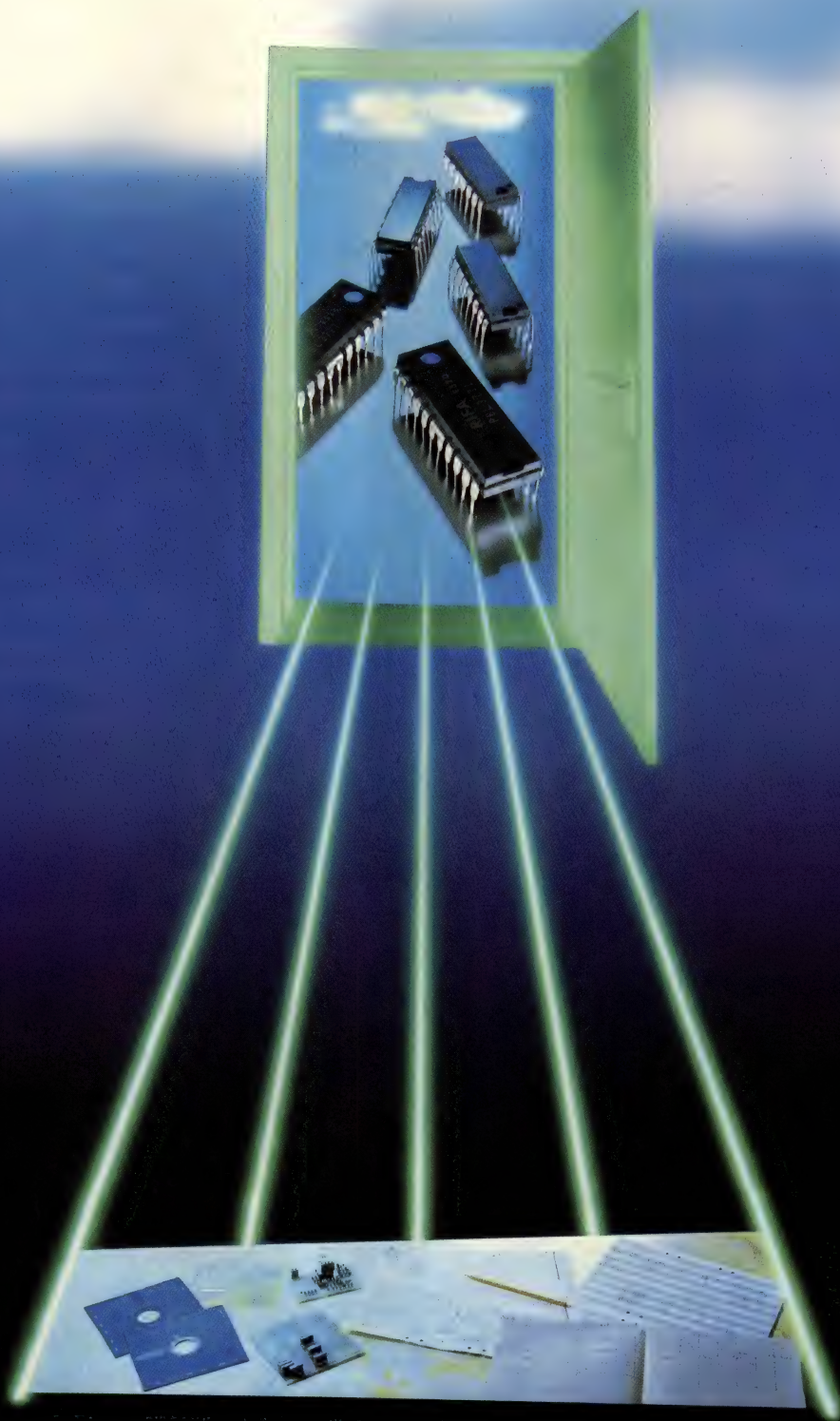
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PBD 3517 Economy driver

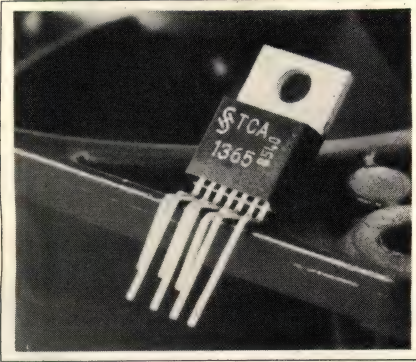
PBL 3717 The industry standard stepper motor driver

PBL 3770 High performance driver

PBL 3771 Precision/microstepping driver

PBM 3960 Microstepping controller

NEW PRODUCTS: INTERNATIONAL



POWER OP AMP

Operating from supply rails as high as $\pm 21V$, the TCA1365 power operational amplifier can deliver output currents as high as 3.5A. The output is protected against short circuits to the supply rails, and against thermal overloads. Other features include the provision for external compensation components, a TTL-compatible inhibit input, and integrated protection diodes. Housed in a TO-220-style package, the TCA1365 has a power rating of 13W and a case operating temperature range of -25 to $+85^{\circ}C$. DM 9 (100).

Siemens AG, Zentralstelle für Information, Postfach 103, 8000 Munich 1, West Germany. Phone (089) 2340. TLX 5210025.

Circle No 396

Siemens Components Inc, 186 Wood Ave S, Iselin, NJ 08830. Phone (201) 321-3400.

Circle No 397

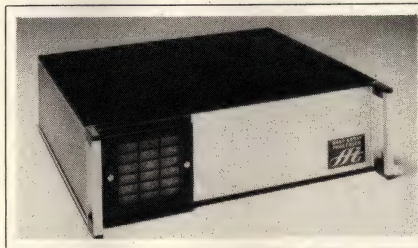
COMM CARD

The SICC-X.25 intelligent communications card allows you to connect VME Bus systems into X.25 networks with the LAPB protocol and X.21 or X.21 bis interfaces. The controller supports permanent virtual connection (PVC) and selectable virtual connection (SVC) for incoming and outgoing calls. The board allows you to configure as many as 63 X.25 channels, any 12 of which may be active at the same time. Programmable parameters include transmission speeds (19.2k baud max), external/internal clocking, DTE or DCE operation, NRZ

or NRZI encoding, packet size, and SVC-channel selection. Onboard firmware executes levels 1 to 3 of the ISO Open Systems Interconnect model and buffers communication packets into local RAM. For systems integration, a Unix V driver and utility software is provided. The IBM SNA protocol is available as an option. The double-Eurocard board connects to the VME Bus via an A24/D8 master/slave interface and an interrupt requester. DM 6900.

Stollmann GmbH, Max-Brauer-Allee 81, 2000 Hamburg 50, West Germany. Phone (040) 3890030. Teletex (17) 403226.

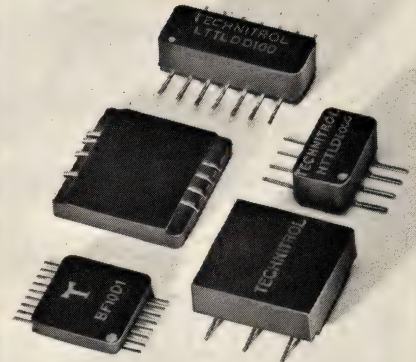
Circle No 398



ARRAY PROCESSOR

Executing arithmetic operations at speeds greater than 6M flops, the Snap (synchronous numeric array processor) enhances the performance of computer systems for math-intensive applications. It's a self-contained unit that incorporates as many as 64M bytes of dual-port memory for communication of data and coefficient information from the host computer. The dual-port memory is accessed via a host-adaptor card and ribbon-cable assembly, which are currently available for the DEC Q22 Bus. The Snap is thus compatible with both PDP Series and MicroVAX systems. The Snap's arithmetic processor supports DEC and IEEE-P754 32-bit floating-point formats, and it can convert data between the two formats. Operations are supported by integer-to-floating-point, and floating-point-to-integer conversion before and after computation. Floating-point addition, subtraction, and multipli-

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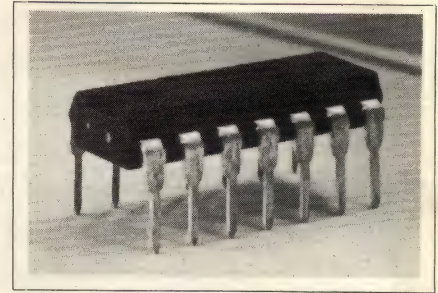
8184

cation all execute within a single 167-nsec instruction cycle, and floating-point division typically converges to 32-bit precision in seven instruction cycles. Software support includes standard library routines in the form of Fortran-callable subroutines, an assembler, an interactive debugger, and a Snap simulator for program development. Oper-

ating-system support software tailors the Snap software to the host operating system. Diagnostic software is provided. From £12,000, including software.

Fast Firmware Techniques Ltd,
151 University Rd, Southampton,
Hampshire SO2 1TS, UK. Phone
(0703) 585550.

Circle No 399



SMPS CONTROL IC

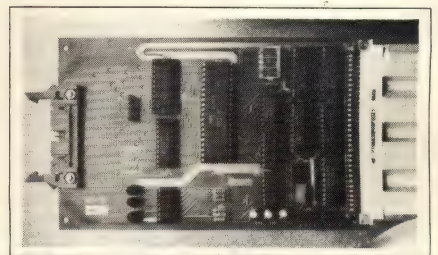
The TDA4814 switch-mode power-supply control IC contains driver circuitry optimized for driving SIPMOS power transistors, an operational amplifier with an 80-dB gain and a 2-MHz bandwidth, and a multiplier that allows you to generate an ac waveform derived from the power supply's output for comparison with the line input current. A current detector input on the TDA4814 then ensures that the SIPMOS transistor is switched to maintain the sinusoidal nature of the line current. DM 5 (100).

Siemens AG, Zentralstelle für Information, Postfach 103, 8000 Munich 1, West Germany. Phone (089) 2340. TLX 5210025.

Circle No 400

Siemens Components Inc, 186 Wood Ave S, Iselin, NJ 08830. Phone (201) 321-3400.

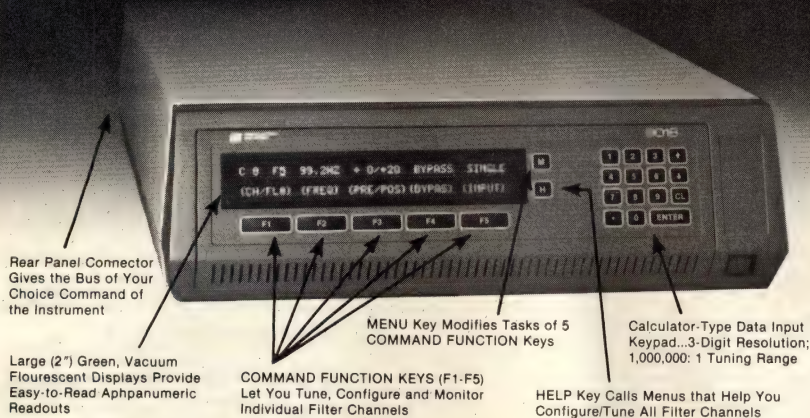
Circle No 401



IEEE-488 CARD

Providing talker, listener, and controller functions, the S488 interface card for the STE Bus allows you to integrate IEEE-488 based instruments and computers into STE Bus systems. Supported IEEE-488 functions include source and acceptor handshaking; talker/listener and extended talker/listener addressing; service requests; remote/local, par-

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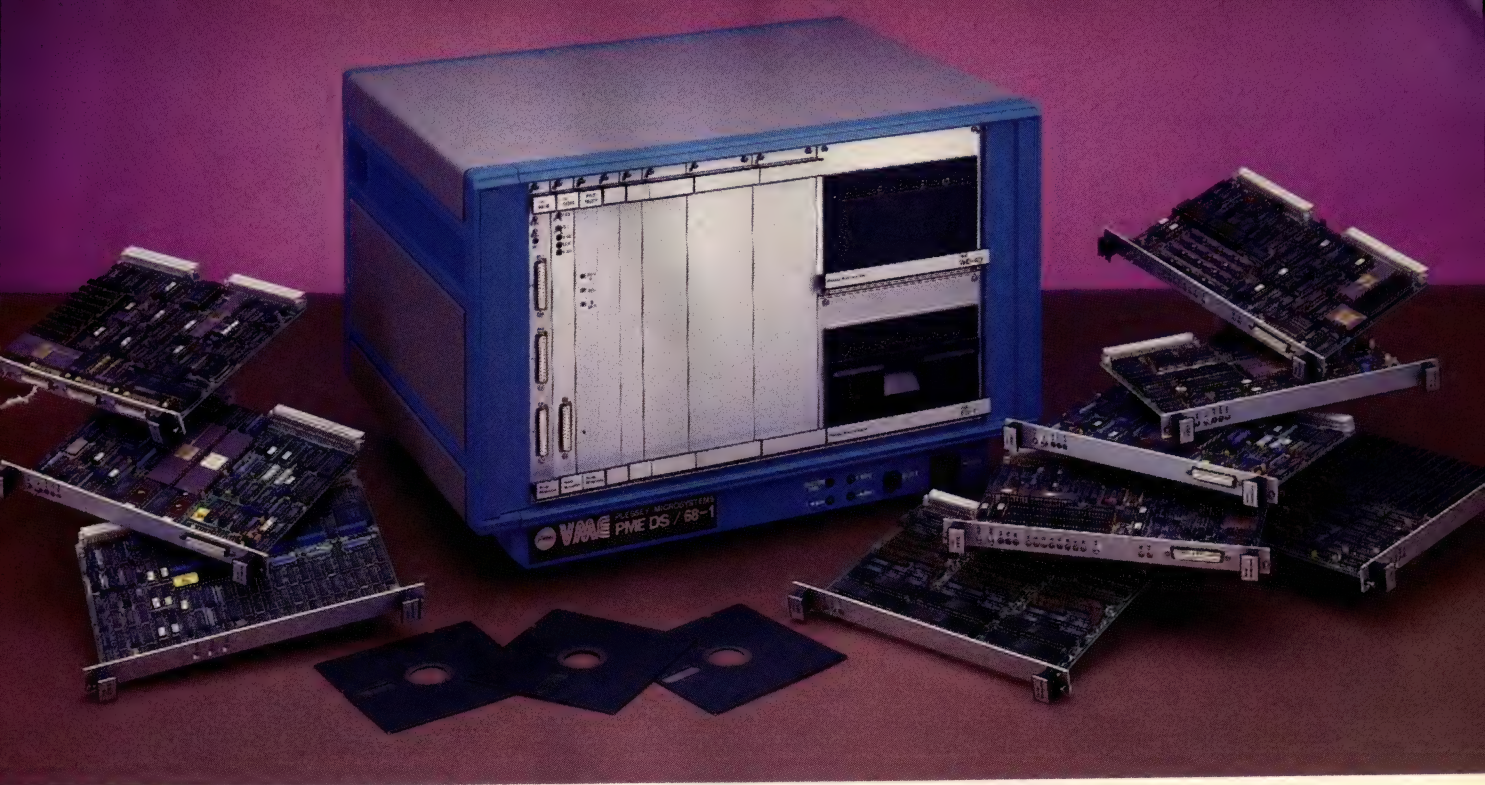
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The PME SASI-1 disk controller works on a 4-channel programmable DMA controller, local diagnostic RS232C channel and interface for Winchester, floppy and tape drives. An FD-1 1 Mbyte floppy drive provides maximum storage on a

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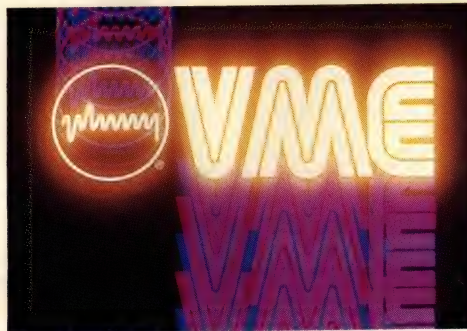
Each backplane features gold-plated Fast-ON power connectors, full termination networks at both backplane ends, and full control of daisy chain signal jumpering. The chassis keeps cool with an internal fan and protected power supply built right into the body.

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EDN 51186

allel polling; device triggering; and controller capabilities. You can transfer data between the STE and IEEE-488 buses using an off-board DMA controller. The S488 card maps into the STE Bus as 10 I/O locations, jumper selectable anywhere within the bus's 4k bytes of I/O space. Onboard switches allow you to set the card's IEEE-488 ad-

dress. This address can then be read by the STE Bus system. The connection between the interface card and the IEEE-488 connector is via a ribbon cable. £151.

Arcom Control Systems Ltd,
Unit 8, Clifton Rd, Cambridge CB1
4WH, UK. Phone (0223) 242224.
TLX 817114.

Circle No 402



HANDHELD TERMINALS

Measuring 156×82×35 mm, each of these handheld terminals incorporates a 40-key keyboard capable of generating the 128-character ASCII set. Depending on the model, received characters are displayed on an 8- or 12-digit LED display, or on a 14-digit LCD. A keyboard-only version is also available. Memory capacity is either 30 or 92 characters; the display can serve as a window to this memory using step and scroll controls. Some versions allow you to prepare and edit a message off line and then send it as a block. Interfaces include RS-232C, -422, -423, and 20-mA loop. Some versions are available with dual interfaces. In all cases, DIP switches allow you to set data-word arrangements, baud rates, and internal control parameters. Power for the terminals comes through an unused pin on the interface connector. An optional rechargeable battery pack provides more than eight hours of continuous operation for LCD models. The terminals can store 4k bytes of control or diagnostic firmware. Standard models from £240 to £265.

G R Electronics Ltd, Fair Oak House, Church Rd, Newport, Gwent NP9 7EJ, UK. Phone (0633) 214147. TLX 497939.

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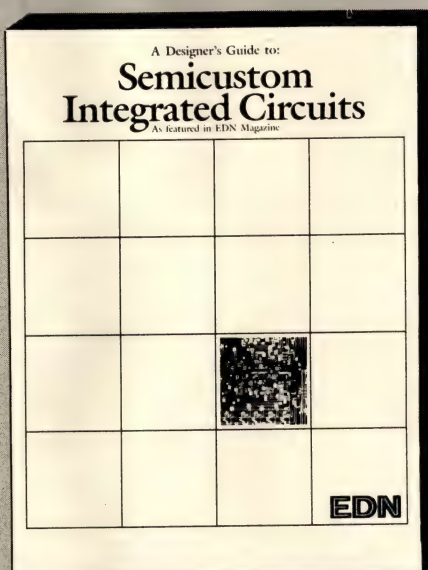
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20 EAST STATE PARKWAY
SCHAUMBURG, ILLINOIS 60195
PHONE (312) 843-7500 FAX (312) 20-6577

At Nichicon, we want to help you find your capacitor choice.

Miniature Aluminum Electrolytic Capacitors

Series Type	Feature	Operating Temp. (°C)	D.C. Leakage Current (μA)	Construction	Rated Voltage (V.DC)	Capacitance Range (μF)	Standard Capacitance Tol. (%)
LB	• Standard Size • General Purpose	-40 ~ +85	0.03CV (A*) (4μA Min.)	Radial (U) Axial (T)	6.3-100	0.1-10,000	±20 (M)
VX	• Smaller Standard Size • High CV Density • General Purpose	-40 ~ +85	0.01CV (B*) (3μA Min.)	Radial (U)	6.3-100	0.47-10,000	±20 (M)
HU	• High Voltage	-25 ~ +85	0.06CV + 10 (C*)	Radial (U) Axial (T)	160-450	1-100	-10 ~ +50 (T)
BU	• High CV Products	-40 ~ +85	0.02CV (C*) (3000μA Max.)	Radial (U)	160-450	1-470	-10 ~ +50 (T)
VS	• Low Profile Design	-40 ~ +85	0.01CV (B*) (3μA Min.)	Radial (U)	6.3-50	0.1-4,700	±20 (M)
KB	• Low Leakage • Tantalum Replacement	-40 ~ +85	0.002CV (B*) (0.4μA Min. - U) (1μA Min. - T)	Radial (U) Axial (T)	6.3-100	0.1-100	±20 (M) / ±10 (K)
SA	• Super Miniature (7mm Height) • Tantalum Replacement	-40 ~ +85	0.01CV (B*) (3μA Min.)	Radial (U)	6.3-50	0.1-100	±20 (M) / ±10 (K)
SL	• Super Miniature (7mm Height) • Tantalum Replacement • Low Leakage	-40 ~ +85	0.002CV (B*) (0.4μA Min.)	Radial (U)	6.3-50	0.1-100	±20 (M)
SP	• Super Miniature (7mm Height) • Non-Polarized	-40 ~ +85	0.05CV (B*) (10μA Min.)	Radial (U)	6.3-50	0.1-47	±20 (M)
MA	• Ultra-Miniature (5mm Height) • Tantalum Replacement	-40 ~ +85	0.01CV (B*) (3μA Min.)	Radial (U)	4-50	0.1-220	±20 (M)
EB	• Non-Polarized	-40 ~ +85	0.01CV (C*) (5μA Min.)	Radial (U) Axial (T)	6.3-100	0.47-1,000	±20 (M)

Miniature High Temperature Capacitors

PC	• Standard Size • Wide Temp. Range • General Purpose	-55 ~ +105	0.03CV (A*) (4μA Min.)	Radial (U) Axial (T)	6.3-100	0.47-10,000	±20 (M)
BB	• High Temperature • High Reliability	-40 ~ +105	0.002CV (C*) (2μA Min.)	Radial (U) Axial (T)	10-100	0.47-1,000	±20 (M)
BE	• High Temp. (+125°C) • High Reliability	-40 ~ +125	0.002CV (C*) (2μA Min.)	Radial (U) Axial (T)	10-50	0.47-470	±20 (M)
ST	• High Temp. (+105°C) • Super Miniature (7mm Height)	-40 ~ +105	0.01CV (B*) (3μA Min.)	Radial (U)	6.3-50	0.1-100	±20 (M)

Miniature Special Application Capacitors

PX	• Low ESR • Smaller Package • High Ripple	-55 ~ +105	0.03CV (A*)	Radial (U)	6.3-63	22-2,200	±20 (M)
TM	• For Timing Circuits • Very Stable at High Temp.	-40 ~ +85	0.001CV + 1 (B*)	Radial (U)	10-50	1-470	±20 (M) ±10 (K)
HA	• High Frequency, High Ripple	-25 ~ +85	100 (C*)	Radial (U)	25	2.2-10	±10 (K)

Can Type Lytics

HL/L	• Snap-In Terminal for P.C.B. Mount	-40 ~ +85	3V CV (C*)	Can (L)	16-100	470-22,000	-10 ~ +30 (Q)
UB	• Snap-In Term., P.C.B. Mount • Smaller Size	-40 ~ +85	3V CV (C*)	Can (L)	16-100	1,000-15,000	±20 (M)
NW/NK/NS	• Computer Grade	-25 ~ +85	3V CV (C*) (10mA Max.)	Can (L)	6.3-450	120-1,000,000 (1F)	-10 ~ +50 (T)
PS (LR)	• Snap-In Term., P.C.B. Mount • For Switching Regulators • [Smaller Size]	-40 ~ +85 (160-250) -25 ~ +85 (350-450)	3V CV (C*)	Can (L)	160-450 [400]	47-1,000 [47-330]	±20 (M)
PK	• High Ripple, Switching Reg. • Extended Temp. Range • Snap-In Term., P.C.B. Mount	-40 ~ +105	3V CV (C*)	Can (L)	200-250	150-1,000	±20 (M)
GM (GF)	• High Ripple, Switching Reg. • Extended Temp. Range • Snap-In Term., P.C.B. Mount • [Smaller Size]	-40 ~ +105 (160-250) -20 ~ +105 (400)	3V CV (C*)	Can (L)	160-400 [400]	47-1,000 [47-330]	±20 (M)
FL	• Low Profile (20mm Height) • Snap-In Term., P.C.B. Mount • For Switching Regulators	-40 ~ +85	3V CV (C*)	Can (L)	160-250	82-270	±20 (M)

Class III Semiconductive Ceramics

Series Type	Temperature Characteristics	Rated Voltage (V.DC)	Capacitance (μF)	Standard Capacitance Tolerance	Insulation Resistance (MΩ)	Dissipation Factor (at 1kHz)
HET	Y5T	12	0.022-0.47		12V: 0.022-0.1μF 0.22μF 0.33μF 0.47μF	-1 Min. -0.5 Min. -0.33 Min. -0.25 Min.
HEV	Y5V	12	0.047-0.47	±20% (M) +80 ~ -20% (Z)	25V: 0.01-0.22μF 0.47μF 50V: 0.01-0.22μF -500 Min. -1,000 Min.	12V: 7.0% Max. 25V: 5.0% Max. 50V: 5.0% Max.
		50	0.01-0.1			

Polyester Capacitors

Series Type	Rated Voltage (V.DC)	Capacitance (μF)	Standard Capacitance Tolerance	Insulation Resistance	D.F.
OYA	100	0.001-0.47	±5% (J) ±10% (K) ±20% (M)	9,000MΩ/Min.	1.0% Max. at 1kHz
OXM (Radial)	250, 400, 630	0.01-2.2	±5% (J) ±10% (K) ±20% (M)	<0.33μF: 9,000 MΩ/Min.	1.0% Max. at 1kHz
OAM (Axial)	250, 400, 630	0.15-10	±5% (J) ±10% (K) ±20% (M)	>0.33μF: 3,000 MΩ/Min.	1.0% Max. at 1kHz
OAL	125V AC	0.0047-0.22	±10% (K) ±20% (M)	9,000MΩ/Min. at 100 V.DC 1 Min.	1.0% Max. at 1kHz

(A*) = Leakage Current after 1 minute (B*) = Leakage Current after 2 minutes (C*) = Leakage Current after 5 minutes



NICHICON (AMERICA) CORPORATION

927 EAST STATE PARKWAY
SCHAUMBURG, ILLINOIS 60195

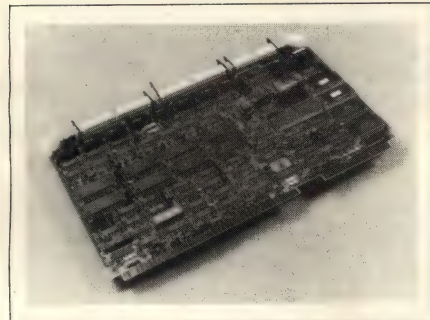
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CIRCLE NO 212

consists of a library containing more than 700 program modules, which are provided as subroutines for the C programming language. Most of the modules are also available as interactive menu-driven programs for image analysis. The library modules support a variety of image data structures (including 2-D arrays and dynamic data structures, for example), linked lists, or index-addressed tree structures, any of which may contain other complex data structures as elements. You can also generate your own data structures to develop customized hierarchical systems, and you can add custom functions to the program library. Algorithms supplied for image-to-image processing include pixel operations, local operands, edge detection, area segmentation, and histogrammic and image-transformation functions. Pattern generation and graphics primitives are also provided. DM 18,500.

Eltec Elektronik GmbH, Galileo-Galilei Str 11, Box 65, D-6500 Mainz 42, West Germany. Phone (06131) 50031. TLX 4187273.

Circle No 404



SERIAL I/O CARD

The PMM-IOP-1 intelligent I/O subsystem provides Multibus I (IEEE-796) systems with eight channels of RS-232C serial I/O for use in a Unix environment. An onboard 8086 μ P handles many of the operations normally carried out by the Unix terminal handling the routines. As a result, the number of host interrupts is held to 16 per sec max, even when you operate all channels simultaneously at 9600 baud. You can also

configure one channel as a Centronics-compatible parallel port. The I/O subsystem interfaces to the host via a 16k-byte onboard dual-ported RAM, which contains eight 1500-byte circular output buffers and one circular input buffer shared by all eight channels. £937.50 (100).

Plessey Microsystems, Water Lane, Towcester, Northants NN12 7JS, UK. Phone (0327) 50312. TLX 31628.

Circle No 405

Plessey Microsystems, 1 Blue Hill Plaza, Pearl River, NY 10965. Phone (914) 735-4661.

Circle No 406



MULTIUSER μ C

Operating in a full multiuser environment, the XP816S computer system supports as many as 31 users running CP/M-, CP/M-86-, and MS-DOS-compatible software. Each user is provided with an 80186 μ P, 1M byte of local RAM, two serial ports, and an optional 8087 math coprocessor. Shared resources include as many as 450M bytes of disk storage and a 60M-byte tape streamer. The computer supports the Turbodos operating system to provide such facilities as file and record locking, print spooling, and password protection. The computer also supports Turbonet for networking systems together. A 16-user system with 110M bytes of disk



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With a Pearson current monitor and an oscilloscope, you can measure pulse or ac currents from milliamperes to kiloamperes, in any conductor or beam of charged particles, including those at very high voltage levels.

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Telephone (415) 494-6444
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CIRCLE NO 213

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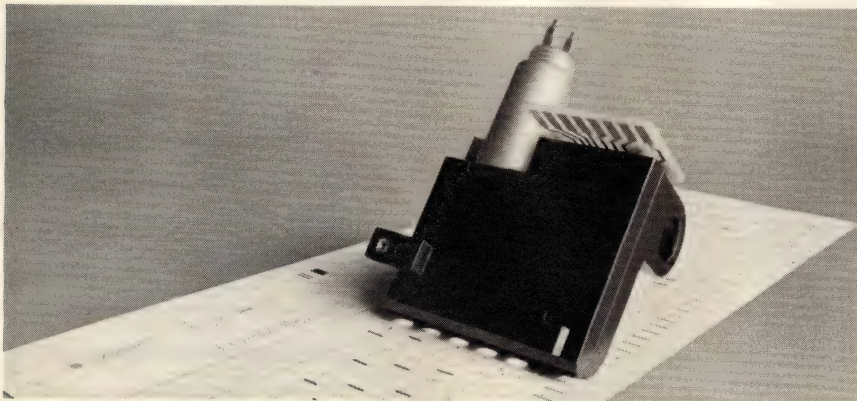
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Industrial Products Division
Jordan Road, P.O. Box 187
Skaneateles Falls, New York 13153-0187
Telephone: (315) 685-8945

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CIRCLE NO 214

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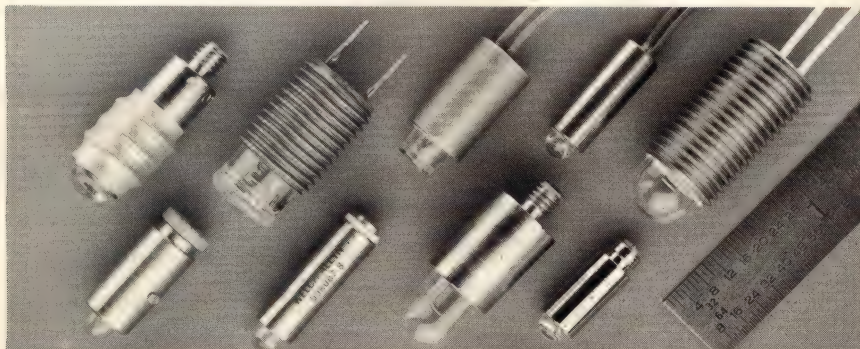
Over 140 standard lamps are available in a variety of base and lens configurations and in a range of electrical characteristics from 2 to 15 volts, .25 to 2.5 amperes, .5 to 35 watts, and a color temperature of 2100 to 3300° Kelvin. Manufacturing flexibility, from hand to state-of-the-art automation, allows cost-efficient production in both low and high volumes.

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INTERNATIONAL

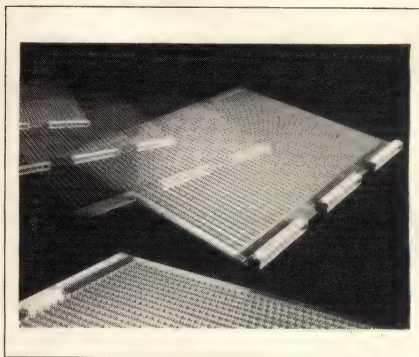
storage and a 60M-byte tape streamer costs less than £2000 per user. Delivery, four to eight weeks ARO.

Equinox Computer Systems Ltd, 114/116 Curtain Rd, London EC2A 3AH, UK. Phone (01739) 3450.

Circle No 407

L/F Technology, 2800 Lockheed Way, Carson City, NV 89701. Phone (702) 883-7611.

Circle No 408



PROTOTYPING CARD

The EQC-UK3XHA Quick-Connect prototyping board has a hyperextended triple-Eurocard form factor, suiting it to Futurebus board development. The double-sided, through-hole board is available either fully populated with Quick-Connect terminals and DIN 41612 connectors, or populated according to customer requirements. You have the choice of B- or C-body DIN connectors, gold-plated terminals, and the number of populated connector positions. Fully populated card, £417.60.

Dage (GB) Ltd, Eurosem Systems Div, Rabans Lane, Aylesbury, Bucks HP19 3RG, UK. Phone (0296) 33200. TLX 83518.

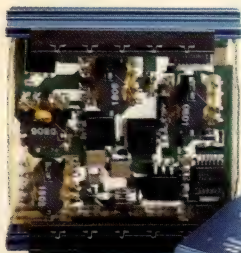
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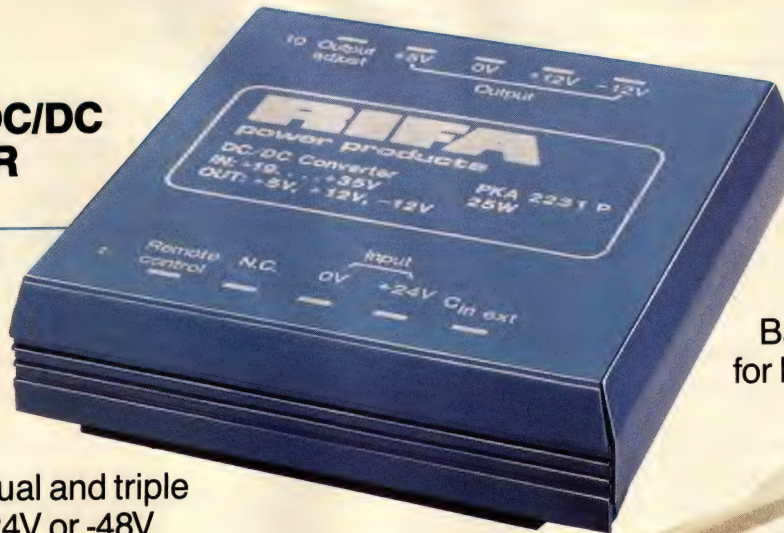
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Complete units which are simple to use and are directly pc board or chassis mountable. No extra components. And no extra cooling.

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CIRCLE NO 216

HIGH-LEVEL DEBUGGER

DOS PScope is a symbolic debugger for high-level languages. It runs on an IBM PC/XT, PC/AT, and compatibles running DOS 3.0 or later. By using high-level procedures and variable names and labels, you can observe program execution at the source-code level. You can go through a program one assembly instruction at a time, one high-level statement at a time, or one entire set of procedures at a time. In addition, you can set breakpoints and trace points at the source-code level to suspend program execution and then display or change the values of variables. When trace operations uncover bugs, you can modify the program's algorithms. Using the debugger's Pascal-like command language, you can create program patches and insert them into the code without having to re-edit the source code. You can also group frequently used command sequences into macros to avoid re-entering keystrokes. \$995.

Intel Corp., Literature Dept W280, 3065 Bowers Ave, Santa Clara, CA 95051. Phone (408) 987-8080.

Circle No 410

DATABASE MANAGER

Team-Up, a database manager and application generator for IBM PCs, can support as many as 4 billion records per file and incorporate 1000 fields per record. It can work with as many as 255 files simultaneously. Maintaining as many as 100 indices per file (all active, with fully automatic, dynamically maintained indexing), it has as many as 1900 characters per field, with as many as 8187 characters per record. It can work with 32,000 applications per system, calling upon any 255 related applications for any transaction (as many as 10 per report). Besides supporting as many as 5000 math operations to an 18-digit accuracy, the software can work with 100 key items, 100 sort keys, 200 query or

search items, and 14 data-item formats or types. Its multi-user versions support as many as 32 security groups with as many as 10 security levels per group. The system requires a hard disk, 256k bytes of RAM, and DOS 2.0 or higher on an IBM PC, PC/XT, PC/AT, or compatible system. Single-user system package, \$795; multi-user system package, \$1795.

Unlimited Processing Inc., 8382 Baymeadows Rd, Suite 8, Jacksonville, FL 32216. Phone (904) 731-8330.

Circle No 411

AUTOMATIC BACKUP

Backtrack automatically backs up files from a hard disk to PC/T tape, to another hard disk, or to floppy disk. Operating in a background mode, it searches for any new or revised files on a hard disk. You can elect to have the program scan your disk at regular intervals, or at specified times during the day. If you need to run a program while the backup operation is in progress, the backup operation is suspended; it resumes when the computer becomes inactive. You can also choose to have the program make backups while the computer is in operation. \$179.

Tallgrass Technologies Corp., 11100 W 82nd St, Overland Park, KS 66214. Phone (913) 492-6002.

Circle No 412

DATA ACQUISITION

Midas (multitasking integrated data acquisition software) for the IBM PC, PC/XT, or PC/AT now offers enhanced scheduling and report-generation capabilities. Interfacing to dBase III, the package compiles and prints reports while on line, so no information from the monitored process is lost. It sends information to the company's Scheduler program, which averages, formats, and records that information into the appropriate file. During the

Scheduler setup, you choose what channels you want data from, how often Midas should read the data, and how many readings should be averaged together. You also specify the file type Midas should write to. You can format information into virtually any sort of report, from cost analysis to billing functions to usage statistics. A standard program monitors as many as 512 channels in 1.1 sec, displays bar graphs and channel logs, and performs alarm functions. From \$3500.

Megasystems Inc., 1075 Broken Sound Parkway NW, Boca Raton, FL 33431. Phone (305) 994-6700. TLX 525124.

Circle No 413

DATA ANALYSIS

Dapper is a command-driven data manipulation, analysis, and plotting program for X-Y data processing on an IBM PC or compatible computer with at least 256k bytes of RAM and an 8087 math-coprocessor chip. It includes 50 1-word commands and an extensive on-line Help facility. The program can adjust data by a constant; by exponentiation; by merging or appending data sets; editing by point or area; by calculating integrals, derivatives, logs and anti-logs; or by curve fitting. You can plot results in linear, semi-log, or log-log form by point and/or line; you can also display histograms, scatter plots, and multiple data sets. In addition, you can manipulate data by applying basic statistics or by using an equation. The program allows batch operation, keyboard data entry, and automatic hardcopying. You can store data in binary form to conserve disk space or in ASCII format for transfer to spreadsheets or word processors. Both the program and the user's guide are supplied on 360k-byte, 5¼-in. floppy disks. \$99.95.

SAIC, 3351 S Highland Dr, Suite 206, Las Vegas, NV 89109. Phone (702) 732-0108.

Circle No 414



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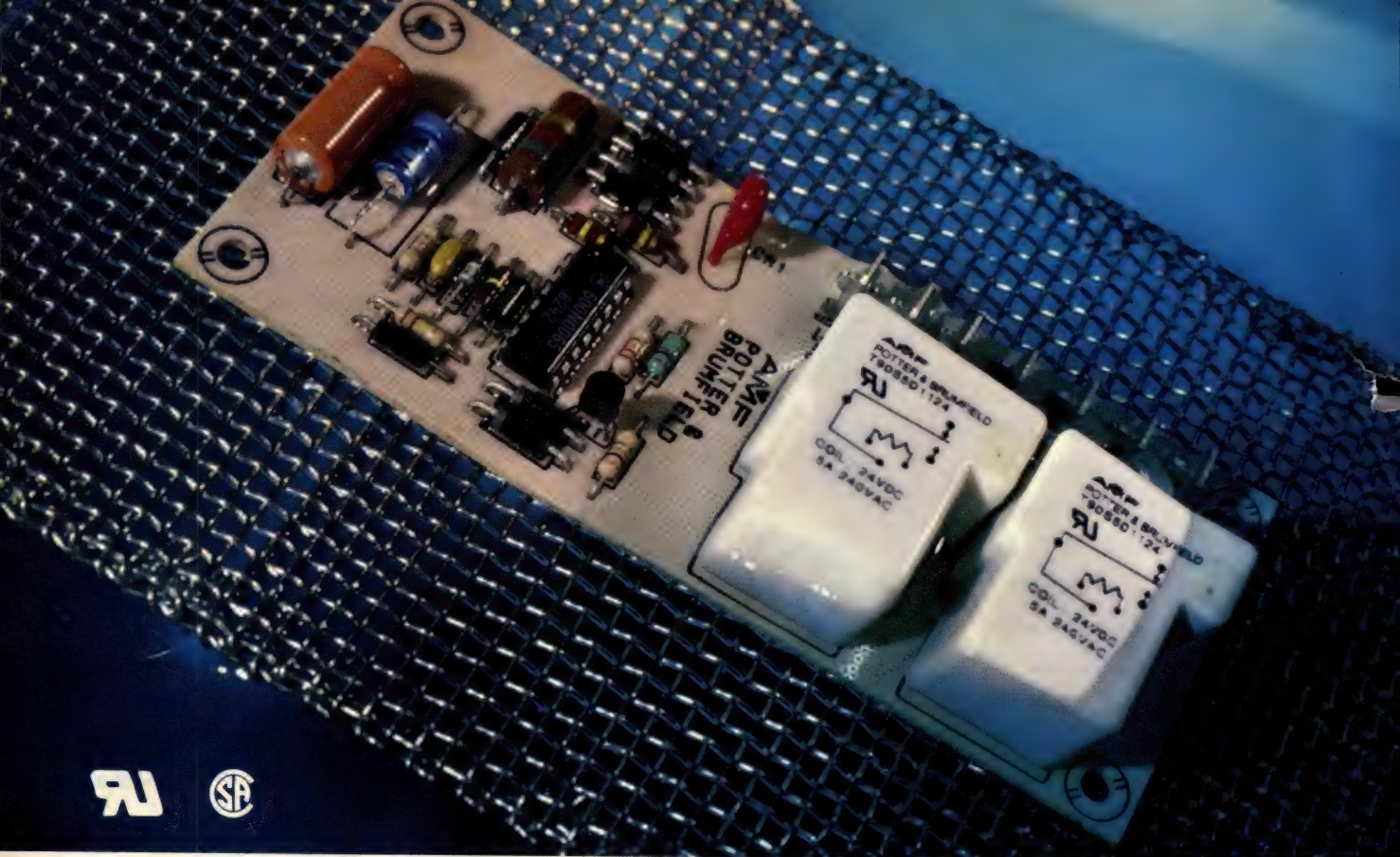
The PIP-512 sells for only \$1995.00 in single quantity.

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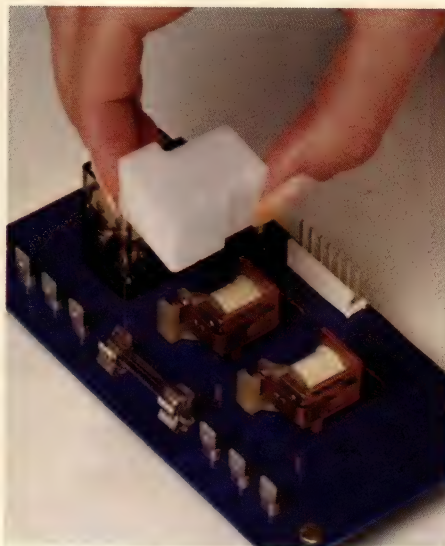
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CIRCLE NO 218

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LAN MANAGER

NMCC/VAX Ethernim is a network-management tool that reports the current, on-line status of an entire Ethernet LAN. Moreover, your LAN may include nodes manufactured by other companies. The monitor runs as a layered software product under the VAX/VMS OS, monitoring LANs by using the Ethernet protocol and DECnet Phase IV network software. It depicts the network graphically and maintains a historical reference file of events. The software can detect any changes to the Ethernet configuration—including the addition of new nodes—and alert LAN managers. By invoking one command, you can initiate a probe of each node to determine the integrity of the network's backbone. Other commands automatically determine if each node is accessible. In addition, the software maintains a permanent, editable database of information on

each node. For the VAX 8600, \$10,500; for all other applicable VAX systems, \$7000 (single-use license).

Digital Equipment Corp., Maynard, MA 01754. Phone (617) 870-3234.

Circle No 415

UNIX SYSTEM V OS

This Unix System V OS, the UTS/580, runs on the manufacturer's 580 Series processors. It runs in three modes: as an OS on a 580 Series processor; in a domain under a 580/Multiple Domain Feature (MDF); or as a guest under VM/SP or VM/SP HPO. The 580/MDF permits users to run UTS/580 concurrently with another OS, such as MVS, without the overhead or expense of VM. The manufacturer claims that C, Fortran, and Pascal programs that conform to programming standards should operate with few or no

changes following compilation in the UTS/580 environment. The system supports traditional Unix full-duplex ASCII terminals and IBM 3270-style terminals. And, it provides support for connecting terminals, workstations, and computers using Ethernet LANs. Prices start at \$4000/month for source code (including central support).

Amdahl Corp., Box 3470, Sunnyvale, CA 94088. Phone (408) 746-6000.

Circle No 416

DIGITIZER DRIVER

Digiware provides the software link between a digitizer and an IBM PC. It's compatible with IBM PCs, PC/XTs, and PC/ATs and supports digitizing tablets from Houston Instrument, Kurta, Numonics, and Summagraphics. Suitable for use by engineers, doctors, and biologists, the package digitizes graphical and

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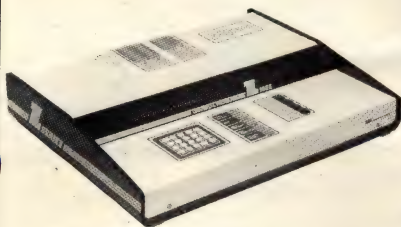
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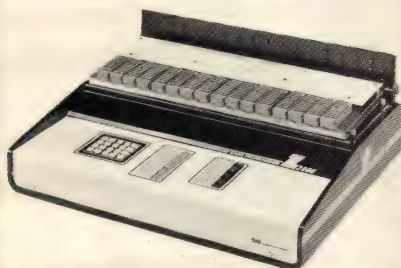
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SOFTWARE

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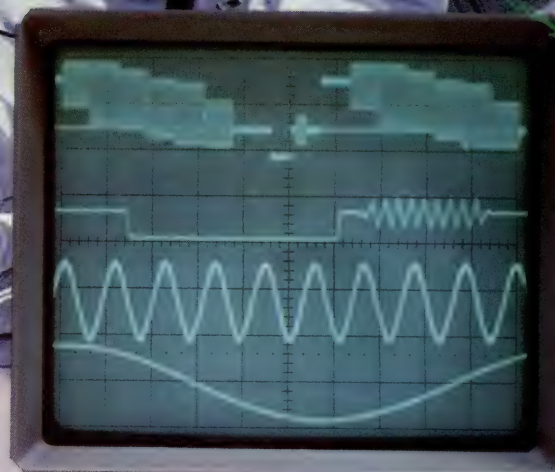
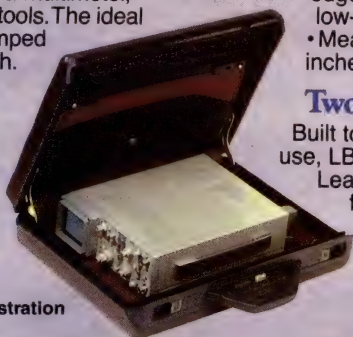
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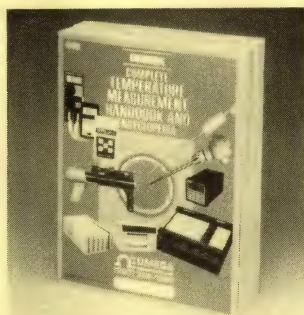
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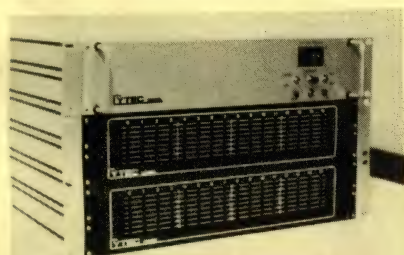
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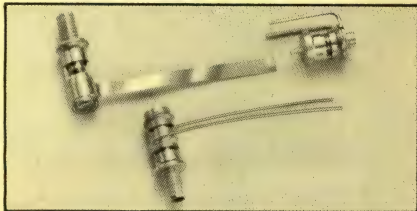
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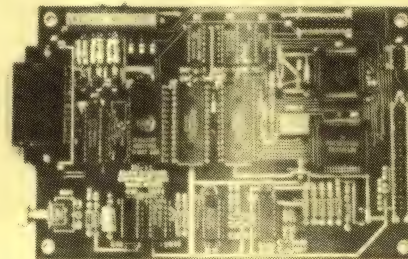
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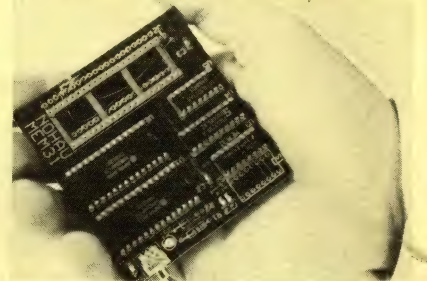
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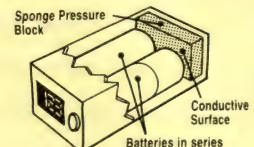
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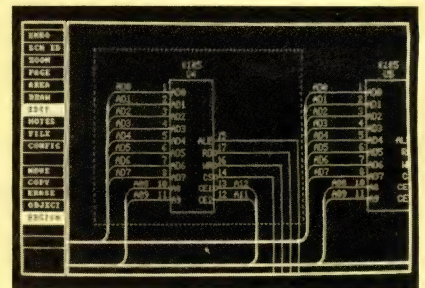
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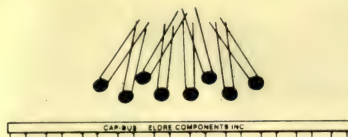
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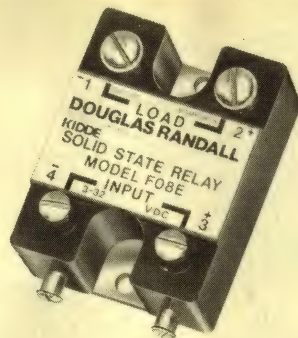


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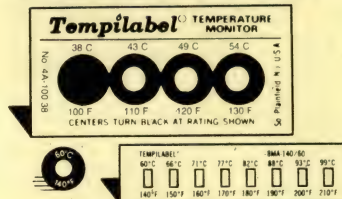


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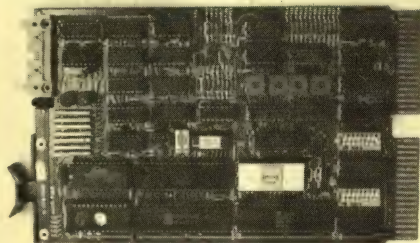


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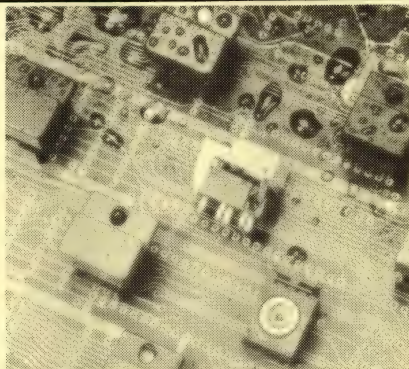
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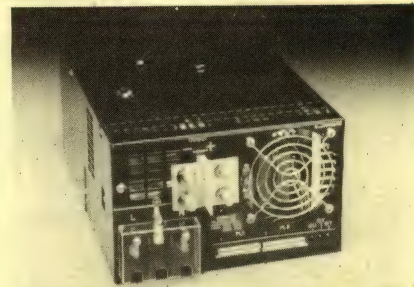
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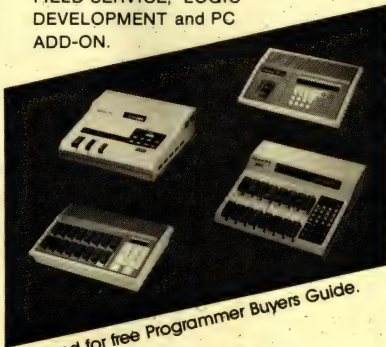


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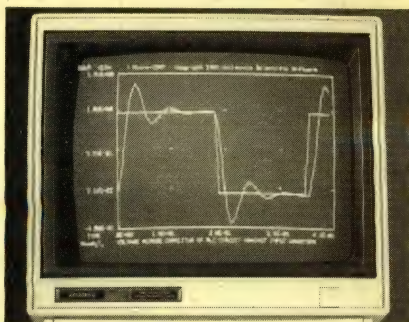
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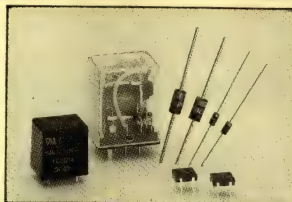
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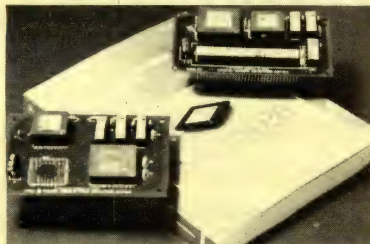
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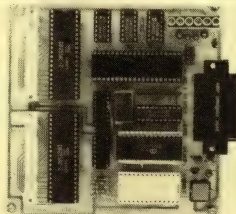
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CIRCLE NO 327



BASIC-52-M Process Controller

This is a powerful tool that can significantly reduce development time for your products. BASIC-52-M offers many hardware and software features:

- Store and run user programs out of EPROM
- Power on execute with no terminal attached
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- 8K/32K RAM
- 8K/16K EPROM
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- Serial Printer Port
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- Onboard EPROM Programmer
- 3 Counter/Timers
- PWM Output
- Extensive Programming and Operating Manuals
- \$449.00 (U.S.)
- \$549.00 (U.S.) for expanded boards
- Termination boards and cables \$75.00 (U.S.) each

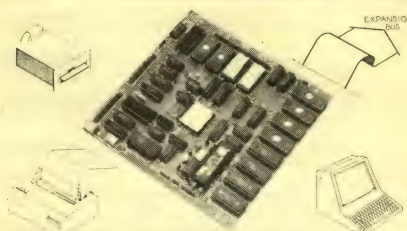


Beck Technology, Inc.

1324 Wallace St., Regina, Saskatchewan

Canada S4N 3Z4 (306) 522-8448

CIRCLE NO 328



OEM188 SBC DEVELOPMENT SYSTEM FOR PRODUCT APPLICATIONS

The OEM188 is designed to bring your product to market in the fastest possible time — through the most productive software development environment available and cost effective hardware.

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- DEVELOP your code quickly with Vesta's ROMmed languages designed for control tasks. Try our WRITE IT, RUN IT, ROM IT development environment.
- MARKET your product profitably; not only will you have a product ready in the fastest possible time, you will have a cost effective one. Size 8" x 8". FDC for 4 drives, Dual UART with RS-232, TTL and RS-422 I/O, Bus — IBM, Printer port, Watchdog, Battery backed real time clock and up to 256K static BBS RAM/ROM. Programmer interface — terminal. Various I/O boards available.

OEM188 fully populated — \$449 each (\$250/1000)

OEM188 kernel system — \$329 each (\$199/1000)

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CIRCLE NO 329

CY525 3rd generation STEPPER MOTOR CONTROLLER

most intelligent controller offers linear ramping, 10,000 steps/sec, unlimited stepping, change rate on the fly, read position on the fly, and much more.



CY512 compatible, 40 pin, +5 volt TTL, 8 bit I/O interface to computer. \$195 ea. (\$80/100) Prototyping board available.

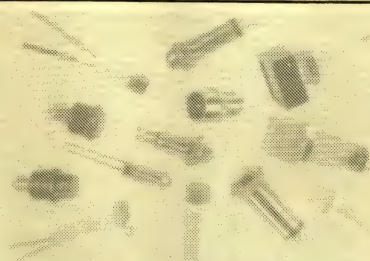


Cybernetic Micro Systems

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CIRCLE NO 330



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Complete selection of attractive, low cost indicator lights in a variety of sizes, configurations, colors, and types — incandescent, neon, green glow, LED, flush and top hat styles, cartridge and holder ... with reflectors, custom legends, etc. Most in stock at competitive prices.



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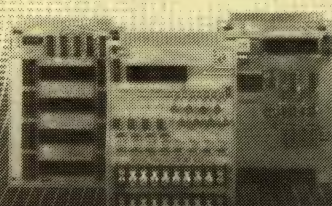
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Glenview, Illinois 60025

(312) 729-5330

CIRCLE NO 331

6800/6809 Micro Modules



OEM 6800/6809 MICROCOMPUTER MODULES for dedicated control and monitoring. Interfaces for sensors, transducers, analog signals, solenoids, relays, lamps, pumps, motors, keyboards, displays, IEEE-488, serial I/O, floppy disks.



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800-742-8809

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25 to 200 ns total delays TTL-Schottky interfaced SMD delay lines come in 5-tap models with total delays from 25 to 100 ns, and 10-tap models from 50 to 200 ns. Designed for auto placement and IR or vapor-phase soldering; these 28-pin (50 mil ctrs.) leaded chip carriers are .465" square, .195" high. Stock delivery.

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EXPANDED CAPABILITIES NEW LOWER PRICE \$1245

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CIRCLE NO 345

8051 8048

SIMULATORS - CROSS ASSEMBLERS - PROGRAMMERS - SIM51 and SIM48 Software Simulators run on IBM-PC, CP/M-80, MS-DOS. Designed for validation & debugging application software. Simulation includes all on chip functions plus expansion chips. \$250, one year **FREE** updates. Formats: PC-DOS 2.x DSD, CP/M-80 8" SSD, many 5 1/4" formats. Cross Assemblers and EPROM pgms also available. **Logical Systems Corp.** 6184 Teall Station, Syr., NY 13217 (315) 478-0722

Logical Systems

CIRCLE NO 343

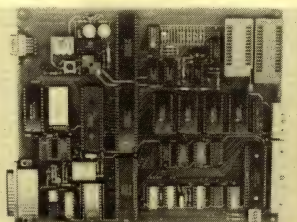
6805 DEVELOPMENT SYSTEM

The Micro-AID/05A and an IBM PC provide complete development support for the 6805 family of single chip microcomputers.

- 6805 Cross Assembler - Two pass symbolic assembler processes 6805 source files.
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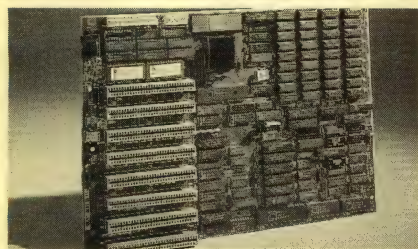
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IBM PC to HP file interchange !!!

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 - 5.25" transfers don't require any additional hardware!
 - 3.5" disk transfers require an ISS FDD35 drive system.
 - runs on the IBM PC, XT, AT and the HP Vectra.
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CIRCLE NO 347



8 Mhz 80286

IBM PC/XT MOTHERBOARD

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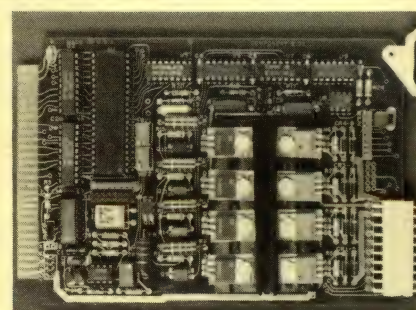
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CIRCLE NO 348



smARTWORK® Circuit-Board-Artwork Software. For only \$895, **smARTWORK®** lets the design engineer create and revise printed-circuit-board artwork on the IBM Personal Computer. Forget the tedium of taping it yourself or waiting for a technician, draftsman, or the CAD department to get to your projects. With **smARTWORK®** you keep complete control over your circuit-board artwork from start to finish. Call or write to **Wintek Corporation**, 1801 South Street, Lafayette, IN 47904-2993. (317) 742-8428, (800) 742-6809.

CIRCLE NO 349



SMART STEPPING MOTOR DRIVE

CHOPPER TYPE STEPPING MOTOR DRIVE PLUGS DIRECTLY INTO STD BUS BACKPLANE. ONBOARD MICROCOMPUTER ACCEPTS BINARY STRINGS FROM HOST PROCESSOR AND PERFORMS TRAP-AZOIDAL PROFILE INDEXES WITHOUT HOST INTERVENTION. ADDITIONAL COMMANDS ALLOW JOG, SCAN AND SET HOME. 22 KHZ CHOPPER SECTION RUNS FROM 18 TO 35VDC AND IS RATED AT 3 AMPS PER PHASE CONTINUOUS.

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CIRCLE NO 350

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HM 65748/49	1 K x 4	25/35/45
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HM 65768/69	4 K x 4	25/35/45
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* Available late 86

New from MHS:
The Ultrafast memory family, that meets all your high speed data-processing requirements.

25/35/45 ns. Three figures tell it all.

They're the access times of the new ultra-fast advanced CMOS COMET[®] memories from MHS. These speeds are the fastest available on the CMOS market. Other COMET[®] features include a wide operating temperature range, CMOS consumption, automatic power down mode, and outstanding resistance to electrostatic discharge. COMET[®] memories are thus an effective

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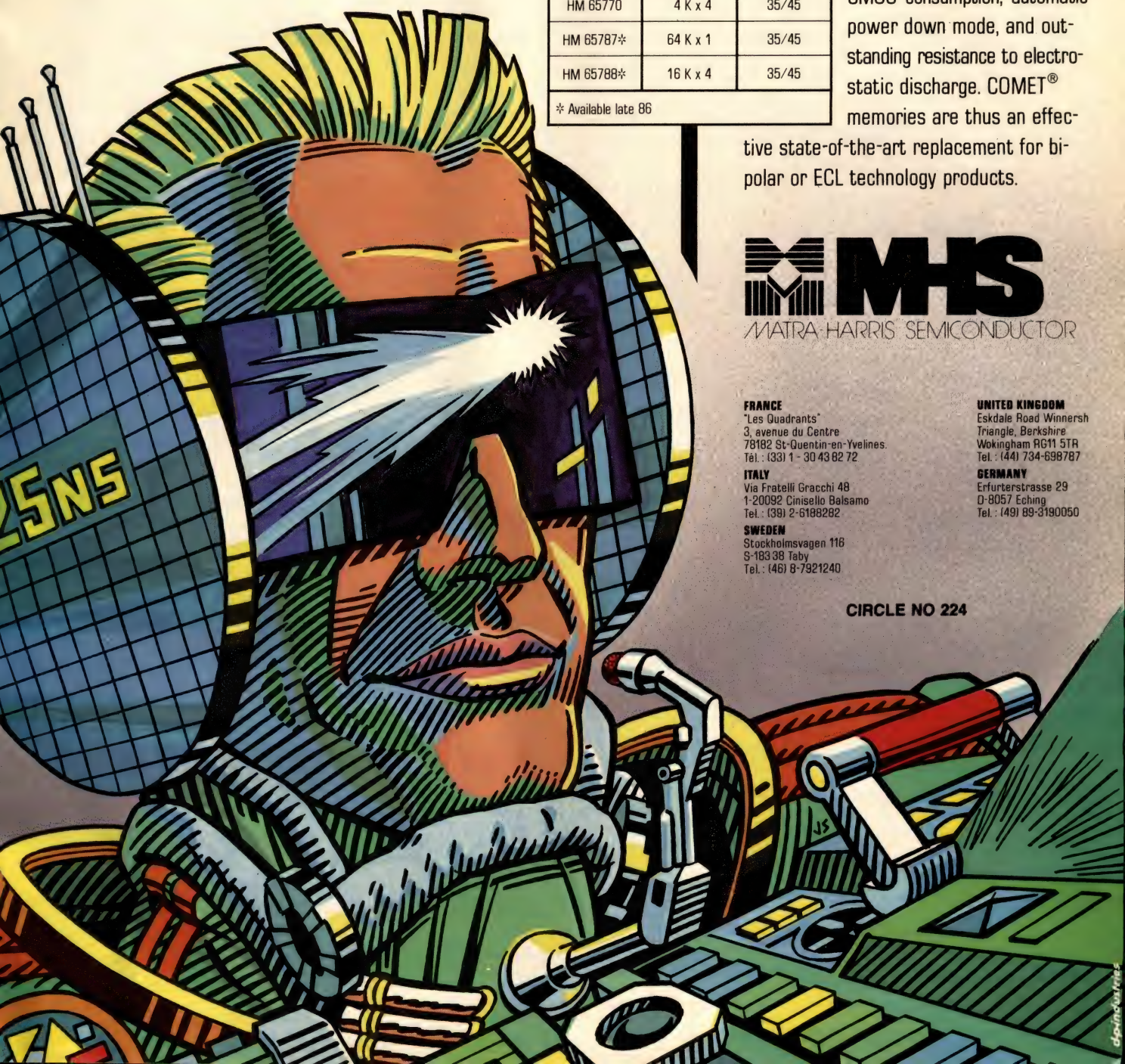
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Tel.: (39) 2-6188282

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Wokingham RG41 5TA
Tel.: (44) 734-698787

GERMANY
Erfurterstrasse 29
D-8057 Eching
Tel.: (49) 89-3190050

CIRCLE NO 224



Book depicts ICs

High Reliability Integrated Circuits contains more than 500 pages detailing the manufacturer's line of digital and linear ICs and discrete devices. The manual includes data sheets, specs, processing and screening procedures, and dimensional drawings, as well as application notes. Among the products described are JAN CD4000B CMOS devices, QMOS CD54HC/HCT ICs, and CMOS/SOS radiation-hardened LSI devices. In addition, a section of the text explains radiation hardening and the types of radiation for which the SOS process provides protection. \$7.

RCA Solid State, Box 2900, Somerville, NJ 08876.

INQUIRE DIRECT



Brochure introduces power operational amplifiers

This brochure, *WR-206*, introduces a family of six power operational amplifiers capable of driving loads to 3.5A and $\pm 20V$. The 16-pg pamphlet covers basic features and typical applications of the drivers with servo motors, single- and 3-phase motors, dc motors, and CRT deflection applications. The applications drawings aren't intended as complete circuit designs: You can obtain additional data from the company's engineering bulletins covering the 27118 Series. The brochure is 3-hole punched for loose-leaf filing.

Sprague Electric Co, Box 9102, Mansfield, MA 02048.

Circle No 443



Periodical addresses G64 Bus

G-64 Only magazine covers industry news, new products, and applications related to the G64 Bus. This first, 34-pg issue contains only articles written by the publisher/manufacturer's staff; however, future issues will feature other authors from other companies. Initially, the magazine will appear every two months; qualifying engineers can receive it free of charge for a 6-month trial subscription.

Gespac Inc, 100 W Hoover Ave, Suite 11, Mesa, AZ 85202.

INQUIRE DIRECT



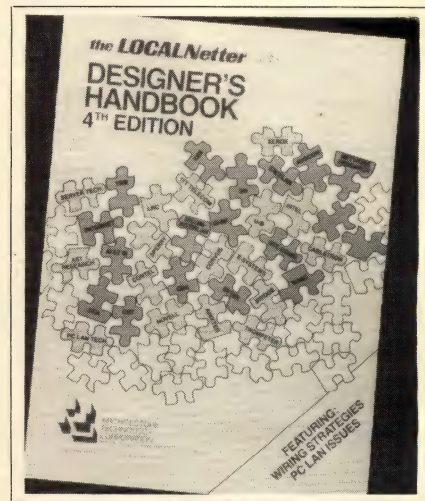
Brochure introduces high-voltage products

This 4-color, 6-pg brochure presents the Hivac high-voltage ICs, which incorporate complementary CMOS/DMOS transistors, SCRs, insulated gate transistors, diodes, and bipolar transistors working at voltages to 500V. It describes how design engineers can use these circuits to eliminate discrete devices, integrate all

drive functions, and add control functions, as well as integrate both ac and dc functions. In addition to descriptions and explanations, the brochure contains a summary of dielectric isolation.

Telmos Inc, 740 Kifer Rd, Sunnyvale, CA 94086.

Circle No 445



Handbook covers LANs

The fourth edition of *The Localnetter Designer's Handbook* contains 14 articles on LAN-related topics in addition to LAN product information. The book offers updated product listings and articles on wiring strategies and PC LAN issues, as well as sections on basic LAN considerations, standards, and local network systems (grouped according to baseband, PC, broadband, and PBX). A listing of international distributors and sales offices has been added. The 496-pg handbook costs \$102 (US); \$132 (foreign).

Architecture Technology Corp, Box 24344, Minneapolis, MN 55424.

INQUIRE DIRECT

Selection guide for ICs

This quick-reference selection guide covers configurable gate arrays, linear ICs, bipolar LSI memory products, digital ICs, and small-signal transistors. In addition to descriptions and specifications, the 96-pg guide contains cross-reference

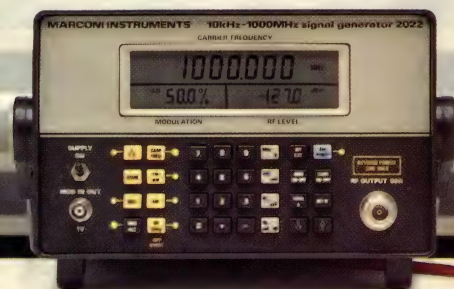
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MARCONI SIGNAL GENERATORS NEVER FORGET

Marconi has been building Signal Generators for 50 years, so it's not surprising that we offer you 40 different models and versions with a full range of modulation capabilities configured with time saving digital control from the front panel and via GPIB ... we also include a non-volatile memory for your most used settings.

The choice includes the 2018A series, covering 10kHz-520MHz and the 2019A series covering from 10kHz to 1040MHz. These models ensure that virtually any requirement can be met in the main general purpose range for RF testing. These unique models have easy-to-use keypads, optional talk and listen GPIB, with the facility to create your own identity string. The internal clock can be used to monitor operating hours, and normal re-calibration which resides in software, can be undertaken without removing the covers.

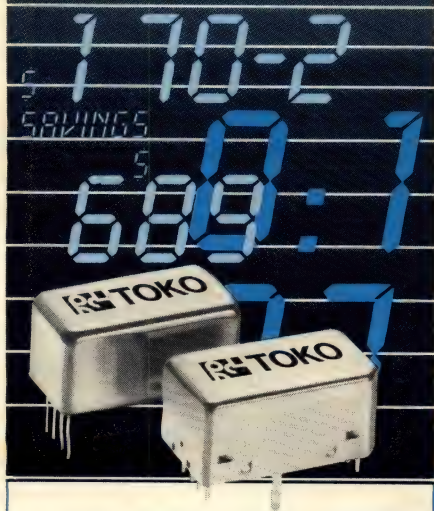
The compact half-rack size Model 2022 is a 10kHz to 1000MHz full performance Signal Generator at an unbeatable price that particularly appeals to manufacturing and service engineers. Easy digital operation, integral reverse power protection, low cost GPIB and it's 100 non-volatile storage location provide and unforgettable performance.

For R & D, the definitive Model 2017 with its exceptional cavity-tuned programmable oscillator, state-of-the-art signal purity, and high output power, is an unbeatable performer. It provides CW, pulse, AM and FM signals at output levels up to +19dBm, with incredibly low spurious content. Ask for the brochures on our full range of Signal Generators. They'll be worth remembering.



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Allendale, NJ 07401
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Toko DC-DC Converters: A Bright Idea for Powering Vacuum Fluorescent Displays.



Whether you're using Futaba, ISE or NEC vacuum fluorescent displays, Toko CPS series DC to DC Converters are the power solution to provide grid, anode and filament voltages - with high reliability and cost savings. They also provide stable power for modems, RS-232 interfaces and other subsystems requiring mixed operating voltages, at prices much lower than other power alternatives. Contact us to be sure you're not over specifying your DC to DC Converter needs.

High performance characteristics:

- ☐ Stable output levels for flicker-free displays
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The CPS series is available in power outputs to 2.4 watts, with input voltages of 1.7 to 30 VDC and output voltages ± 5 to ± 50 VDC or 1 to 10 VRMS AC. For more details and application assistance, contact Toko America today.

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LITERATURE

charts that permit you to identify other companies' devices that you can replace with this manufacturer's, if you wish. Request on company letterhead.

Raytheon Co, Semiconductor Div, 350 Ellis St, Mountain View, CA 94039.

INQUIRE DIRECT



RS-232C interface products characterized

Describing a line of RS-232C interface products, this 16-pg catalog provides features, drawings, photographs, and pricing information. The products are grouped in the following eight categories: computer-port expansion and networking units, interface switches, printer-sharing units, printer buffers, security modems, remote data-collection devices, data multiplexers, and data-distribution devices. Ordering information is included.

Western Telematic Inc, 2435 S Anne St, Santa Ana, CA 92704.

Circle No 448

Users' report covers plotters

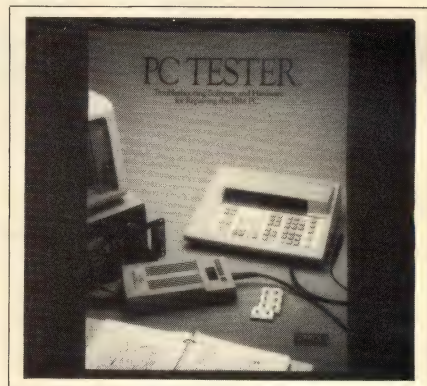
This users' report details specific applications of this manufacturer's electrostatic color and monochrome plotters, interfaces, and controllers. The booklet contains seven sections, categorized according to application: scientific/engineering, electri-



cal, mechanical, architectural, engineering and construction, mapping, and geophysical and business graphics. In each section, users describe system features; accompanying photos and output samples are included.

Versatec, 2710 Walsh Ave, Santa Clara, CA 95051.

Circle No 449

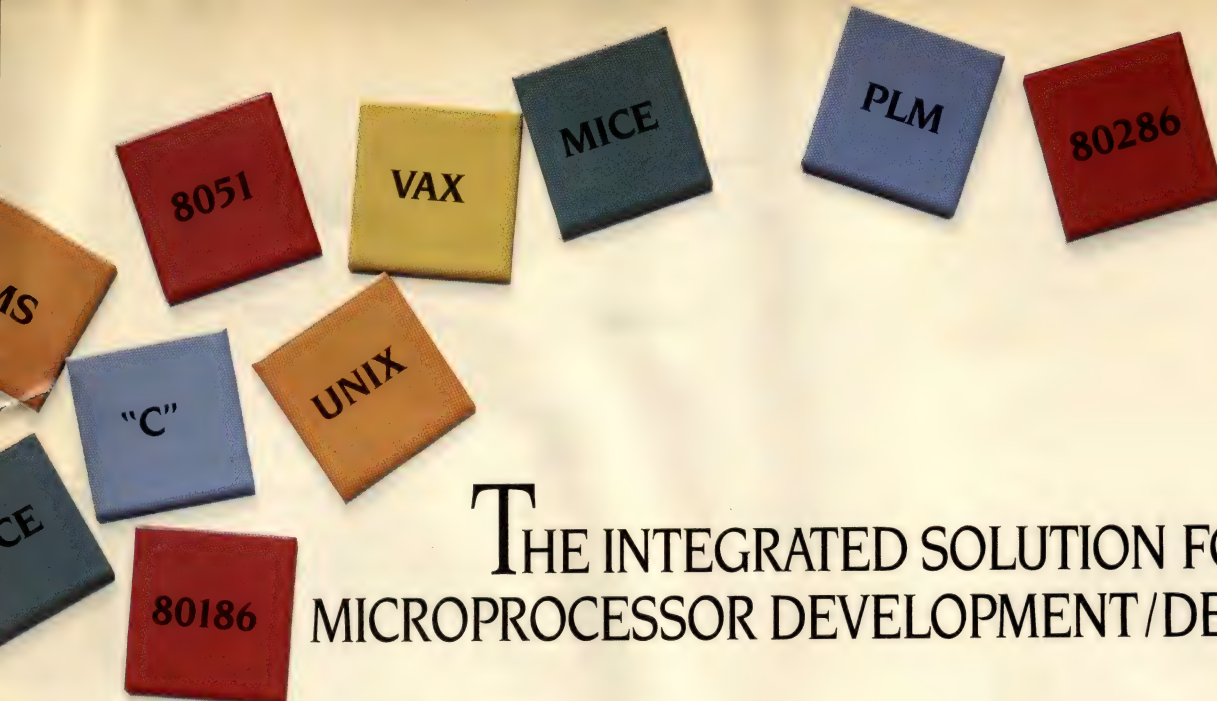


PC tester characterized

This 4-pg full-color brochure describes PC Tester, a combination of the manufacturer's hardware and Techpro software. The Tester typically traces IBM PC faults from the PC's main circuit boards to a specific chip within 30 minutes, according to the manufacturer. The brochure describes system components, which include the manufacturer's 9000 Series Micro-System Troubleshooter and an 8088 microprocessor-interface pod.

John Fluke Mfg Co, Box C9090, Everett, WA 98206.

Circle No 450



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Single vendor convenience and accountability... Multi-vendor flexibility and savings.

Introducing New Micro, the company dedicated exclusively to the integration of popular multi-vendor microprocessor development tools.

A joint venture of both companies, New Micro combines the applications and systems integration experience of ARS Microsystems, Europe's leading development systems house, with the extensive in-circuit emulator design and manufacturing capability of Microtek International, developer of the widely used MICE emulators.*

New Micro does the work for you. We identify and integrate software from our own line, your host computer supplier and third party vendors. The result is a cost-effective system that's tailored to your needs. A system that offers outstanding quality assurance because its debugging software enhances the diagnostic capabilities of its MICE emulators.

The New Micro Solution...

- Minimizes your time spent in locating and integrating programming tools.
- Assures you the most effective combination of software and hardware tools.

Please See us at ELECTRO Booth #393

*New Micro, Inc. is the exclusive U.S. distributor for Microtek International in-circuit emulators.

NOTE: PC-DOS, MS-DOS, VAX/VMS, UNIX, CP/M-86 are trademarks of IBM Corporation, Microsoft Corp., Digital Equipment Corp., AT&T, Digital Research Inc., respectively.

CIRCLE NO 226

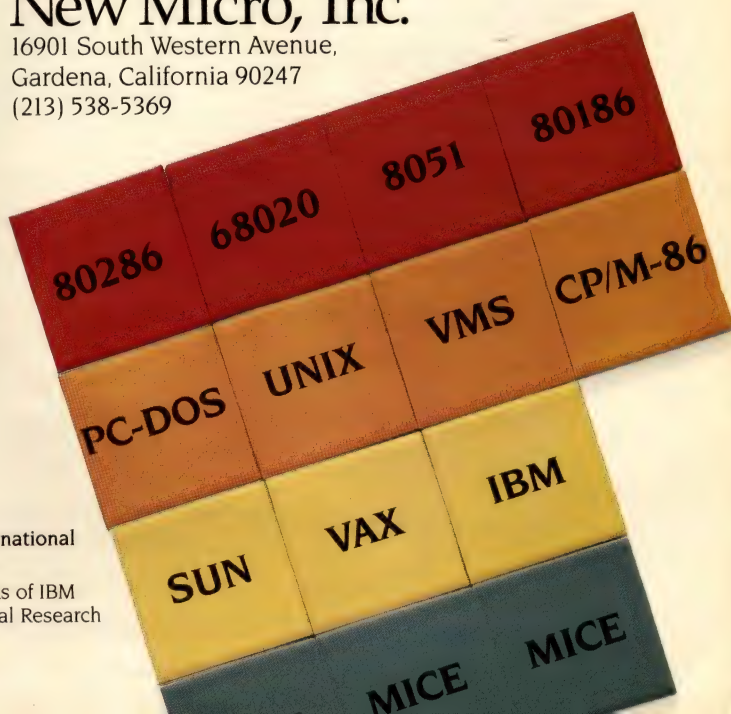
- Helps keep your development time and costs under tight control.
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If your operating system is PC-DOS, MS-DOS, VAX/VMS or UNIX, New Micro can configure a system for your single user, networked or multi-user environments. A system that does the total job with Microtek's emulation and debugging software for all popular microprocessors from Intel, Motorola, Zilog, National Semiconductor and other leading manufacturers.

For an analysis of your system needs, or a demonstration of popular integrated debugging tools with your host system, call us.

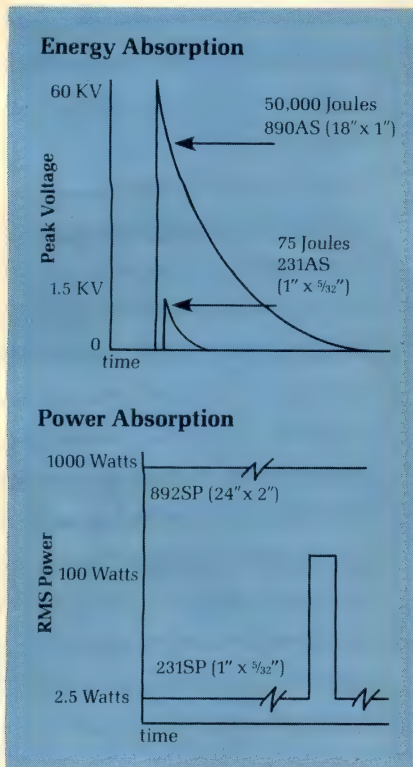
New Micro, Inc.

16901 South Western Avenue,
Gardena, California 90247
(213) 538-5369



Carborundum® noninductive ceramic power resistors solve tough problems.

We make three types of noninductive ceramic resistors that can solve tough resistance problems, save money and space.



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CIRCLE NO 237

LITERATURE

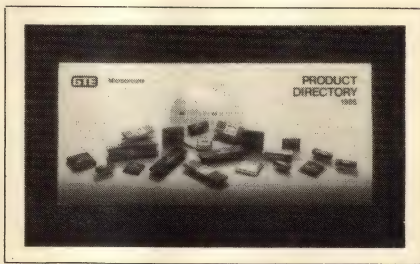


Standard-parts catalog

Featuring current and new products for the first half of 1986, this 16-pg short-form catalog includes five expanded standard-product areas: military ICs, voltage references, dual transistors, op amps, and converters. The catalog describes the manufacturer's line of 6-, 8-, and 11-bit flash converters and 6- to 18-bit D/A converters. Also covered are more than 400 dual transistors. A cross-reference chart shows the products for which the manufacturer is a second source.

Micro Power Systems Inc., 3100 Alfred St, Santa Clara, CA 95054.

Circle No 451



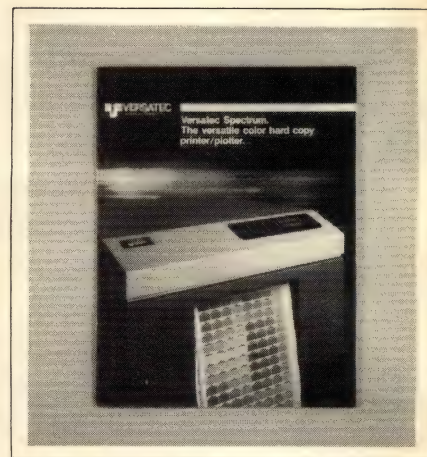
Reference for CMOS ICs

This product directory covers the vendor's advanced CMOS ICs, providing detailed descriptions and technical data. These products include the G65SC00 Series μ Ps, the G65SC150 μ C-on-a-chip, supporting development systems, peripheral control circuits, memory products, communications ICs, gate arrays, standard cells, and logic. The 20-pg directory also describes the company's customer-furnished tooling program, which enables designers with

existing IC designs to produce them using the company's semiconductor fabrication facilities.

GTE Microcircuits, 2000 W 14th St, Tempe, AZ 85281.

Circle No 452



Brochure spotlights plotter

This brochure describes Spectrum, an 11-in. electrostatic color plotter that functions as a printer, plotter, or CRT hard-copy device. The 8-pg, 4-color booklet highlights the advantages of the plotter and includes color plot samples to illustrate its output quality. Specifications are also included.

Versatec, 2710 Walsh Ave, Santa Clara, CA 95051.

Circle No 453

Two brochures present CAD for PLDs, logic analyzer

These two brochures describe the Vista CAD environment for programmable-logic devices and the LA 432 100-MHz logic analyzer. Both products use an IBM PC, PC/AT, or PC/XT as the host. Each 4-color brochure takes the user through a step-by-step description of the products' applications and includes computer-screen photos demonstrating features. The pamphlets also present technical data.

Valley Data Sciences, 2426 Charleston Rd, Mountain View, CA 94043.

Circle No 454



Development System Catches Bugs Before They Become Beasts.

Orion's UniLab II[™] is four instruments in one.

Here's an **Advanced 48-Channel Bus-state Analyzer**, a real-time, real-world, **In-Circuit Emulator**, a **Stimulus Generator** for your special test cases, and a built-in **EPROM Programmer**, all in one small, \$2,995 powerhouse.

To find causes of software and hardware problems, Orion's "Non-intrusive Analysis"[™] concept triggers on bug symptoms you specify. This mature product supports 46

microprocessors with one easy-to-use instrument. Personality Paks get you started fast, and if you need them, Orion's team of Applications Engineers is only a toll-free call away.

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UniLab II

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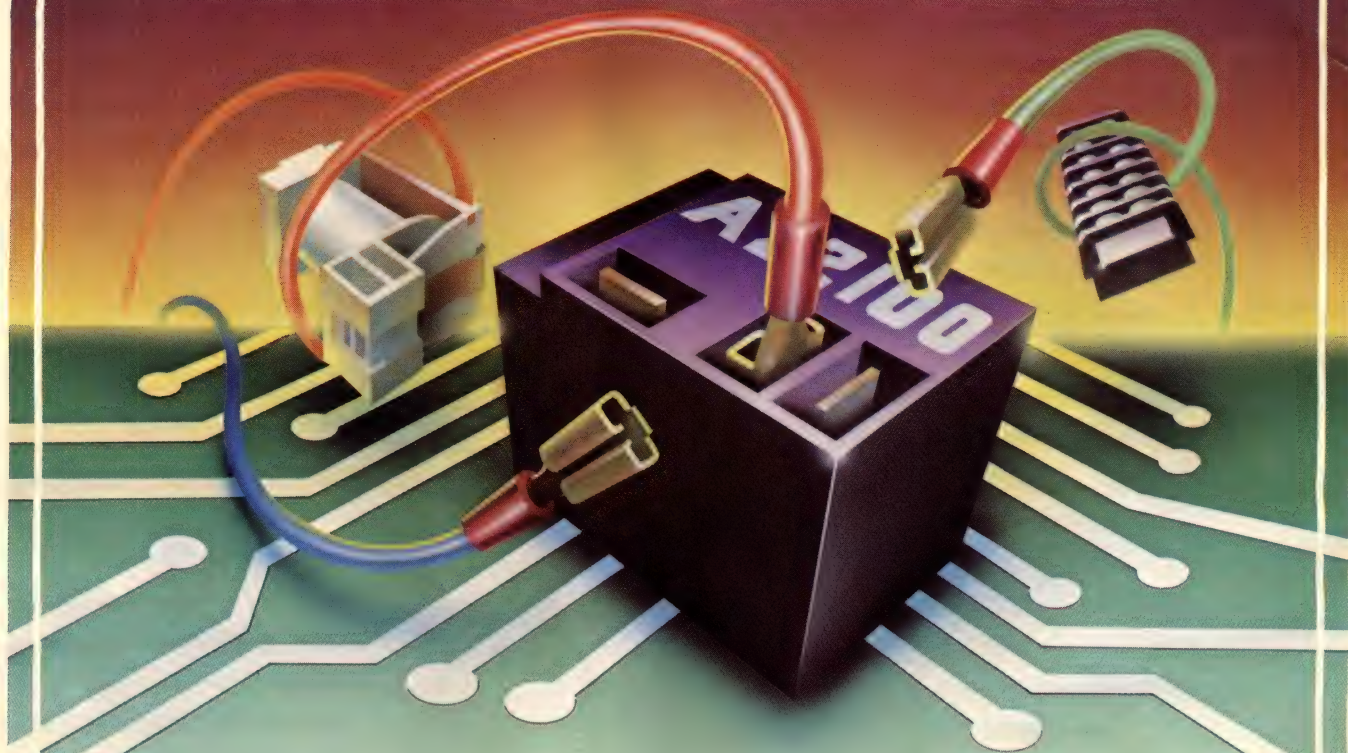
Orion Instruments, Inc.

ORION

702 Marshall Street

Redwood City, California 94063

QUICK CONNECT WITH A BETTER 30 AMP RELAY



THE AZ 2100 GIVES YOU THE OPTION OF ELIMINATING SPACE ROBBERING TRACES AND COSTLY TERMINAL BLOCKS

American Zettler's AZ 2100 Series of high current, low cost, miniature power relays quick connects you with the flexibility of both PC and "trace saver" quick connect terminals. These 30 Amp, high quality relays are offered as both low cost pin-for-pin P&B T-90 replacements and as "trace saver" versions that eliminate power relays requiring the large, space robbing, heat generating traces as well as the costly terminal blocks on the PC board.

The AZ 2100 Series meets the contact load rating and the internal spacing requirements of both UL 508 and UL 873 safety standards.

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Inductive or Resistive @ 30 VDC	20 A
Motor Load @ 240 VAC	2 HP
Motor Load @ 125 VAC	1 HP
Tungsten Lamp @ 125 VAC	15 A
Tungsten Lamp @ 240 VAC	5 A
Ballast @ 125 or 277 VAC	6 A
Pilot Duty @ 125 or 240 VAC	470 VA
LRA @ 240 VAC	80 A
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PROFESSIONAL ISSUES

US, European, and Japanese managers grapple with the same EE career concerns

Deborah Asbrand, *Staff Editor*

Like engineers in the United States, engineers working for electronics companies in Western Europe and Japan desire challenging and satisfying technical work. In fact, despite the different cultural backdrops, engineering careers in industrial countries are much the same. As a result, engineering managers in the US, Europe, and Japan must grapple with the same problems—engineering utilization, career development, continuing education, and advancement.

Despite the culture a company exists in, the attitude of the firm's managers is the major influence on both its employees' satisfaction and its success. The culture at work in every company is the culture of management, says Myron Tribus, director of the Center for Advanced Engineering Studies at the Massachusetts Institute of Technology (Cambridge, MA). Speaking at the IEEE's Annual Meeting earlier this year, Tribus said that although America, Europe, and Japan represent different cultures, the managerial culture of successful companies in the three areas is actually much the same. "When you go to a well-managed plant in the US or in Japan," Tribus says, "you find essentially the same principles at work: The managers and people are all working together to make things go smoothly, they study what they're doing, and they're using the right tools."

Without putting these ideas to work in its own management and

engineering cultures, "no firm can remain competitive and survive today," says Yoshihiro Tsurumi, professor of international business at Baruch College (New York, NY). "Firms must learn to adapt to an environment in which the line between domestic and foreign markets is rapidly disappearing." Because technology can only be channeled by human beings, engineers are critical to a company's

In Japanese companies, the traditional emphasis on effective utilization of employees' talents naturally lends itself to the idea of assigning engineers to different departments throughout the company. Rather than segregating all of a company's engineers within a single engineering department, conventional Japanese policy calls for distributing engineers throughout the design, manufacturing, marketing, and sales sectors. Thus, although their concerns are similar to those of American engineering managers, managers in Europe and Japan often take different approaches to keeping their engineers productive and happy with their jobs.

One way that managers keep their engineers satisfied is to ensure that the engineers have the opportunity to work on challenging projects. For European companies, the most challenging engineering projects often result from cooperative research and

development endeavors with other European companies.

"The heterogeneous structure of the European market is one of our most severe problems," says Karl Beckurts, executive vice president of Siemens AG in Munich, West Germany. "Microelectronics and other high-tech branches are best developed within large and homogenous markets. They require efforts in R&D which call for industrial cooperation. But industrial cooperation in Europe, as a rule, means transnational cooperation, which makes management not only difficult, but also a political venture."



Raymond Medici

ability to remain a contender in world competition. It's critical, therefore, that managers keep their engineers productive and satisfied.

The cultural context in which the companies are set, however, casts a different light on the challenges that managers must deal with. For example, the European electronics industry, which is smaller than that of the US, has a more limited job market and less-competitive salaries for engineers there. In addition, the difficult financial times that European companies have experienced in recent years have had a demoralizing effect on some employees.

Responding to the need to keep European companies competitive in the electronics industry—and indirectly ensuring that engineers at participating companies have the chance to work on cutting-edge technology—members of the European Economic Community have begun collaborating on several research initiatives. One such venture is Esprit, the European Strategic Program for Research and Development in Information Technology, which is an ambitious 5-year program of research into information-processing technologies.

A second program, Eureka, will take on a wide range of research projects, including advanced software technology, third-generation robots, automatic design and production of custom chips via direct printing on silicon, and development of design and manufacturing processes for GaAs ICs. Twenty-nine companies have formed a third initiative called Research and Development in Advanced Communications and Electronics, known as Race. The Race project will study integrated broadband communications.

To begin addressing their engineers' concerns about career development and better use of their engineering talents, managers in two large European electronics companies have eliminated their companies' departmental barriers and integrated their work force, to the benefit of both the companies and their engineering staffs.

Siemens AG, for example, has allocated one-third of its engineering staff to its sales and marketing departments because, Beckurts says, the company "not only sells components and devices, but focuses on finding custom-oriented solutions to problems, a practice which requires a high amount of technical consulting." In addition, 17% of engineers at Siemens AG work in manufacturing and quality assurance, which Beckurts says is a step the company has taken to prepare itself for the automated "factory of the future."

In the European facilities of Philips International BV, better utilization of engineers has been an important part of the company's attempt to satisfy an increasingly complex work force as well as of its efforts to stay competitive. "In cynical circles, it is often said that labor ethics have disappeared, that today's workers are not interested in their work," says Peter Kramer, senior managing director for corporate research at Philips International in

Involving engineers in a variety of technological areas in research and development allows them to hone their own technical skills.

Eindhoven, The Netherlands. "This is complete nonsense." Kramer says that a Philips survey found that the company's Dutch employees maintain a high interest in their work, but now expect their jobs to provide them with much more than just a salary. Employees' job priorities today include self development, challenge, feeling useful, and belonging to an organization.

At Japanese electronics companies, which have a long history of participatory management, a system that uses the breadth of employees' skills has evolved naturally. Like Siemens, NEC (Tokyo, Japan) has contributed to this evolution by distributing the company's engineers throughout all facets of the business. NEC employs 8000 engineers in research and development, 3500 in manufacturing, 2000 in division laboratories, and 1000 in corporate laboratories.

NEC distributes its research and development activities throughout the company in the same manner that it integrates its engineering talent into the various business sectors. Spreading research and development throughout all product sec-

tors makes these activities more responsive to market demands and thereby gives NEC a competitive advantage, explains Michiyuki Uenohara, executive vice president and director of NEC in Tokyo.

Equally important, says Uenohara, is the fact that involving engineers in a variety of technological areas in research and development allows them to hone their own technical skills. Uenohara estimates that each engineer working for NEC represents a \$2.5 million investment for the company—so it's easy to see why NEC views its commitment to its engineering staff so seriously. The company's sense of responsibility to its engineers, however, extends beyond its financial investment in them. "Besides this financial investment, the company is responsible for effectively utilizing engineers, since they are very important resources for the company and society," says Uenohara.

Continuing education is another important component of career development for engineers abroad as well as in the US. As Europe's traditions and cultural diversity present managers there with somewhat different challenges on the issues of engineering utilization and career development, so do they present managers with distinctive challenges when it comes to continuing education. For example, engineers trained in European universities receive a broader and more scientific training than do American engineers, who tend to choose a technical specialty early in their college careers. As a result, European companies have the opportunity to play a large role in developing and maintaining their engineers' specialty skills.

In West Germany, the traditional system of technical training is undergoing changes that have already propelled shifts in company roles. West German engineers receive their training at either a university or a "fachhochschule," a technical school comparable to American

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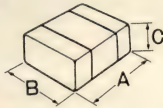


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2.0 x 1.25 x 0.6~1.1	0.5~ 430pF	0.5~ 560pF	0.5~ 680pF	0.5~ 750pF	0.5~ 820pF	0.5~ 1,000pF	0.5~ 1,800pF

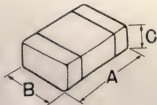
Dimensions: A x B x C (mm)	Class II	
	50V	25V
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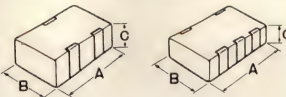
Dimensions: A x B x C (mm)	Inductance (μH)
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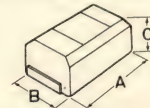
Series designation Dimensions: A x B x C (mm)	Applicable frequency range	Characteristics
MTT (transformers) 4.5 x 3.2 x 2.8	300kHz~1MHz	L: 10~200μH
MIA (AM IFT) 4.5 x 3.2 x 2.5	455kHz, 459kHz 464kHz	Q: above 40
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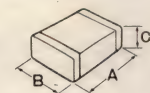
Series designation, Dimensions: A x B x C (mm)	Inductance range (μH)	Q
NL 3.2 x 2.5 x 2.2	0.12~100	20~30
NL 4.5 x 3.2 x 3.2	1.0~1,000	30~50
NLF (shielded) 4.5 x 3.2 x 3.2	1.0~1,000	30~50



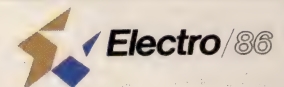
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3.2 x 2.5 x 1.3	37~77	0.105~0.121
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PROFESSIONAL ISSUES

community colleges. Traditionally, university training was considered to be preparation for work in research and development as well as high-level management positions. Fachhochschule education typically consisted of a shorter training program that readied students for more practical engineering tasks, says Beckurts.

But West Germany's educational conventions are changing. Because of the perceived higher status of university training, the programs there have been attracting larger numbers of students, while enrollment at the fachhochschulen has declined. At Siemens AG, about two-thirds of the company's 30,000 engineers are fachhochschule graduates. In 1985, however, the number of new engineers hired by the company was almost evenly split between university and fachhochschule graduates.

To guarantee that graduates of both systems receive adequate practical training, Siemens AG has taken on a collaborative role in engineering education. It has equipped about 20 schools with the company's CAD system and will fabricate some of the students' chip designs at its Munich silicon foundry. To keep its own engineers up to date, Siemens AG maintains internal continuing-education programs. In 1985, the company spent the equivalent of \$270 million on internal training and continuing education.

Philips International also emphasizes continuing education for its engineers, but leaves much of the responsibility up to the individual engineers. "Since our engineers have a broad education . . . during their training at the university, they have to become specialists as adults," says Kramer. "Philips gives them ample room for that—discussion with colleagues, contacts with research, reading literature, attending conferences—but basically they must do it themselves." One way in which Kramer hopes to see the company act as a booster for its

engineers is by allowing engineers to spend approximately 15% of their time on work of their own choosing.

Despite the firms' different thrusts, representatives of both companies believe European engineering education is on a par with the training available in the United States. In Europe, says Beckurts, "Engineering quality is not just identified with success in getting a problem solved or a device working. The quest is for technical elegance,

Managers in two large European companies have eliminated departmental barriers and integrated their work force, to the benefit of both the companies and their engineering staffs.

cost effectiveness, and reliability of a product." Kramer views European engineers' broader background as an asset. "Our engineer is less specialized, which makes him more flexible and able to change to a neighboring discipline."

According to Tsurumi, American engineers and their employers would do well to adopt some of the strategies of European and Japanese companies. He blames the attitudes of "status-conscious" American engineers for prohibiting them from reaping the benefits of such systems. "In the US, no self-respecting engineer would be caught dead mingling with technicians and production workers on factory floors," Tsurumi says. "Many American engineers have come to believe that their task is to design products and production processes without ever considering how their new products will be made at the factories and how their products will be greeted by customers. They do not wish to be associated with such lowly creatures as sales engi-

neers and industrial engineers, much less with field sales forces."

An engineer's technical prowess, in fact, was of secondary importance to Masaru Ibuka, founder and honorary chairman of Sony Corp, when he was building the company in 1946. "Since Sony's beginning, my criterion for hiring people has been to hire people who love to work," says Ibuka. "It was of secondary importance to me how much technical knowledge or skill a person possessed. Going through very difficult projects gives employees the best training and experience, so what one has in the beginning does not matter much."

Proper training of young recruits is an important concern at Philips, where Kramer says 50% of engineers have been with the company for fewer than five years. "They're coming in with expectations now, and I'm worried about how we'll keep them happy." When Kramer went to work for Philips 25 years ago, one out of six engineers was promoted to high-level management positions. Now that the company employs what he calls "armies of engineers," opportunities for advancement to upper management positions are fewer.

Managers in companies that employ so many engineers have yet to solve the problem of satisfying engineers' needs for advancement. But because they're focusing on keeping engineers' jobs challenging and satisfying, a solution to the problem may be closer. Kramer believes that it's important for all engineering managers to have a better understanding of engineers. "In many industrial corporations, engineers become the real engine of the company . . . It is up to managers to pay more attention to the proper use and maintenance of that engine."

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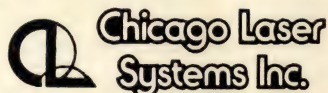
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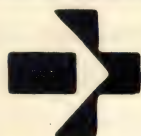
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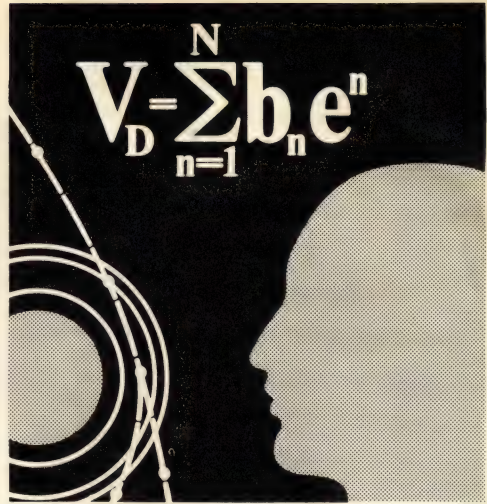
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The Science of Range-Doppler Imaging

Fundamental range-Doppler radar imaging methods developed at ERIM are providing new capabilities in a variety of applications.

Range-Doppler Imaging

Fine Resolution microwave or laser images of objects which are rotating with respect to the radar system can be formed using the principles of range-Doppler imaging. Range resolution for such a system is provided by ranging with wideband waveforms subjected to pulse compression to accurately measure distance to the scatterers of interest. Cross-range, or azimuth, resolution is provided by performing Doppler-frequency spectral analysis (FFT) within range bins. Signals with higher Doppler frequency content are associated with scatterers of greater line-of-sight velocity which in turn implies increasing cross-range offset from object center. Display of the range bins and Doppler-frequency cells within range bins in a rectilinear grid results in a reflectivity image of the rotating object or scene.

With this approach, finer azimuth resolution is obtained by performing the Doppler spectral analysis over increasing time intervals. However, as one strives for finer resolution the integration time can become so long that individual scatterers begin to move through the image resolution cells that one is attempting to form. In such a case the

resultant image quality actually degrades with increased integration time.

Polar-Format Algorithm

A number of image-formation algorithms have been formulated to compensate for the effects of motion through cells during the integration period. The Polar-Format Algorithm, developed at ERIM for use with our ground-based and airborne imaging radar systems, has become widely noted as an extremely powerful, yet elegantly simple and efficient method for overcoming these previous limits of imaging capability. The images below show a Volkswagen and its associated microwave range-Doppler image processed using the Polar-Format algorithm. This image was produced using the ERIM ground-based, range-Doppler imaging facility.

Applications

Fine-resolution range-Doppler imaging is applicable to a number of situations, including space object imaging (SOI), Inverse Synthetic Aperture Radar (ISAR), and Spotlight-mode SAR for airborne imaging of ground scenes. In principle, the approach is suited to both optical and radar wavelengths. Also, the theory has been extended to allow for three-dimensional imaging of objects given suitable signal collection configurations.

The Environmental Research Institute of Michigan (ERIM) is a scientific research institute that performs contract research services for a variety of sponsors. Our sponsors include government organizations, industry, and universities. Research at ERIM focuses upon remote sensing systems, devices, and techniques that span the electromagnetic spectrum. Within this broad research area, staff members employ their knowledge of modern electronics, optics, computer science, and infrared and microwave physics.

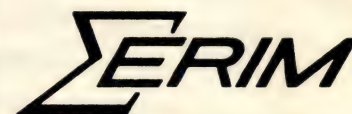
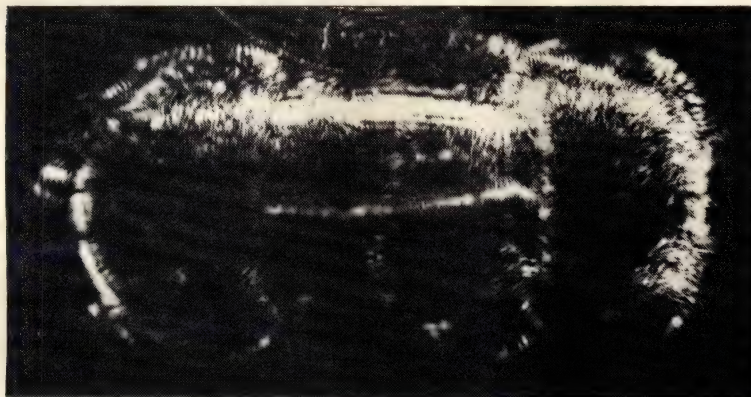
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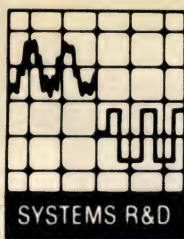
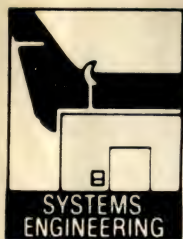
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LOOKING AHEAD

EDITED BY GEORGE STUBBS

Integrated-software market to peak in 1988

The future of integrated software is a future "in which none of the current products are likely to dominate," reports Input, a Mountain View, CA, research firm that specializes in the computer and communications industries. As the market emerges from its current overcrowded, fragmented state, shipments of tightly integrated software packages will increase from 770,000 in 1984 to a high of 1.6 million in 1988. Shipments will fall in 1990, to 1.4 million.

The dollar value of the market will be smaller in 1990 than it is today. In 1985, customers purchased \$440 million worth of integrated software packages; in 1990, the total market value will be \$315 million. The average price of a package in 1984 was \$525; in 1990, it will be \$225.

These shipment and dollar figures are for tightly integrated, "all-in-one" software packages, which com-

bine several functions in a single package. Other types of integrated software include modularly integrated packages, in which a series of programs from the same vendor can work together as a set, and operating-environment software, which is the basis for integration of other programs and for which shipments will also peak in 1988, as the nearby graph shows.

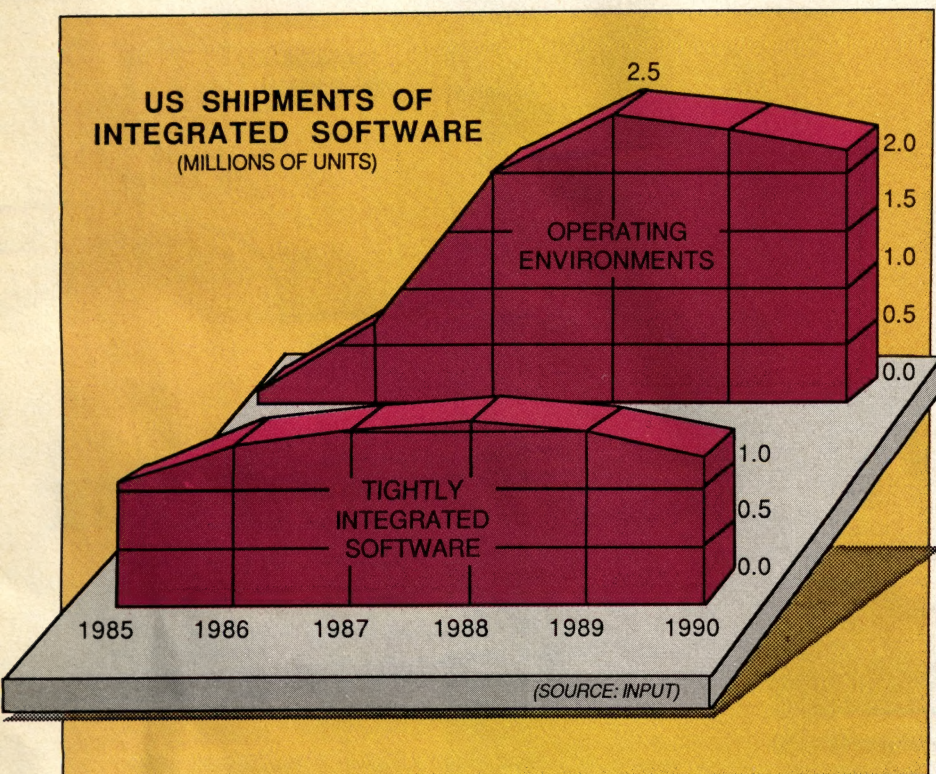
Although the first generation of integrated software has met with only limited success, says Input, future generations will do much better. Decreased storage costs and technological advances in processing power; artificial intelligence; and multitasking, multiuser operating systems will help increase the size of the market. According to the company, "to take... advantage of these and other improvements in the technology, integrated software vendors must provide connectivity, flexibility, and extendability."

Market for F-O test systems to be worth \$500M by 1994

As fiber-optic technology slowly but steadily works its way into telecomm, datacomm, and other applications, the need for fiber-optic test equipment grows commensurately. According to Market Intelligence Research Co (Palo Alto, CA), the market for F-O test equipment will be strong, growing from \$32 million in 1984 to \$500 million in 1994. Unit sales will increase from 1984's 6100 to 86,000 in 1994.

The military has long been a user of fiber optics, in missile telemetry and other systems. In recent years, the driving force behind the advance of light-wave transmission systems—and consequently of F-O test equipment—has been the telecommunications industry. The phone companies, in particular, have been installing F-O trunks in the public switched telephone system. Telecomm applications, however, will account for a decreasing market share, while industrial and datacomm applications will start calling for more and more F-O systems and instruments. MIRC sees three major types of instruments in the market: power meters, light sources, and optical time-domain reflectometers.

In examining difficulties that slow down the advance of fiber optics, the study points out, first, that the industry is young, and the associated test equipment currently has a lifetime of only about three years; second, that because of a lack of standards, potential customers are reluctant to commit too heavily to a single company—a company that may be locked out of the market should the standards axe fall the wrong way; and, finally, that prices of F-O systems and equipment remain high.



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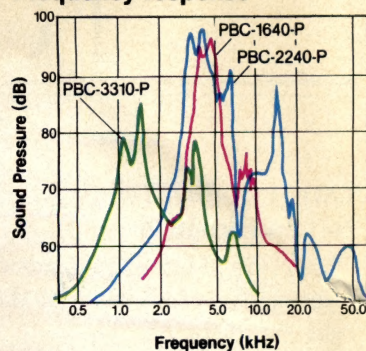
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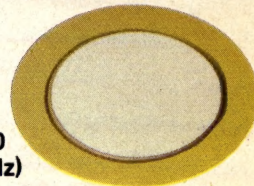


Specifications

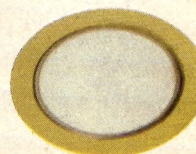
Model	PBC-3310-P	PBC-2240-P	PBC-1640-P
Item			
Sound pressure (dB)	≥ 70	≥ 75	≥ 70
Electrostatic capacitance (nF)	60 ± 30%	12 ± 30%	9 ± 30%
Allowable input voltage (Vp-p)	30	30	30
Dimensions (mm)	φ33 × 14 ^H	φ22 × 7.7 ^H	φ16 × 7.5 ^H

Piezoelectric elements

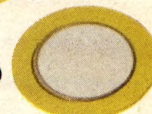
T3525-20
(fr: 2.8 kHz)



T2720-20
(fr: 4.6 kHz)



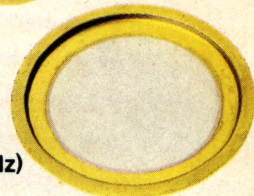
T2014-20
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T1410-10
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T3223-10
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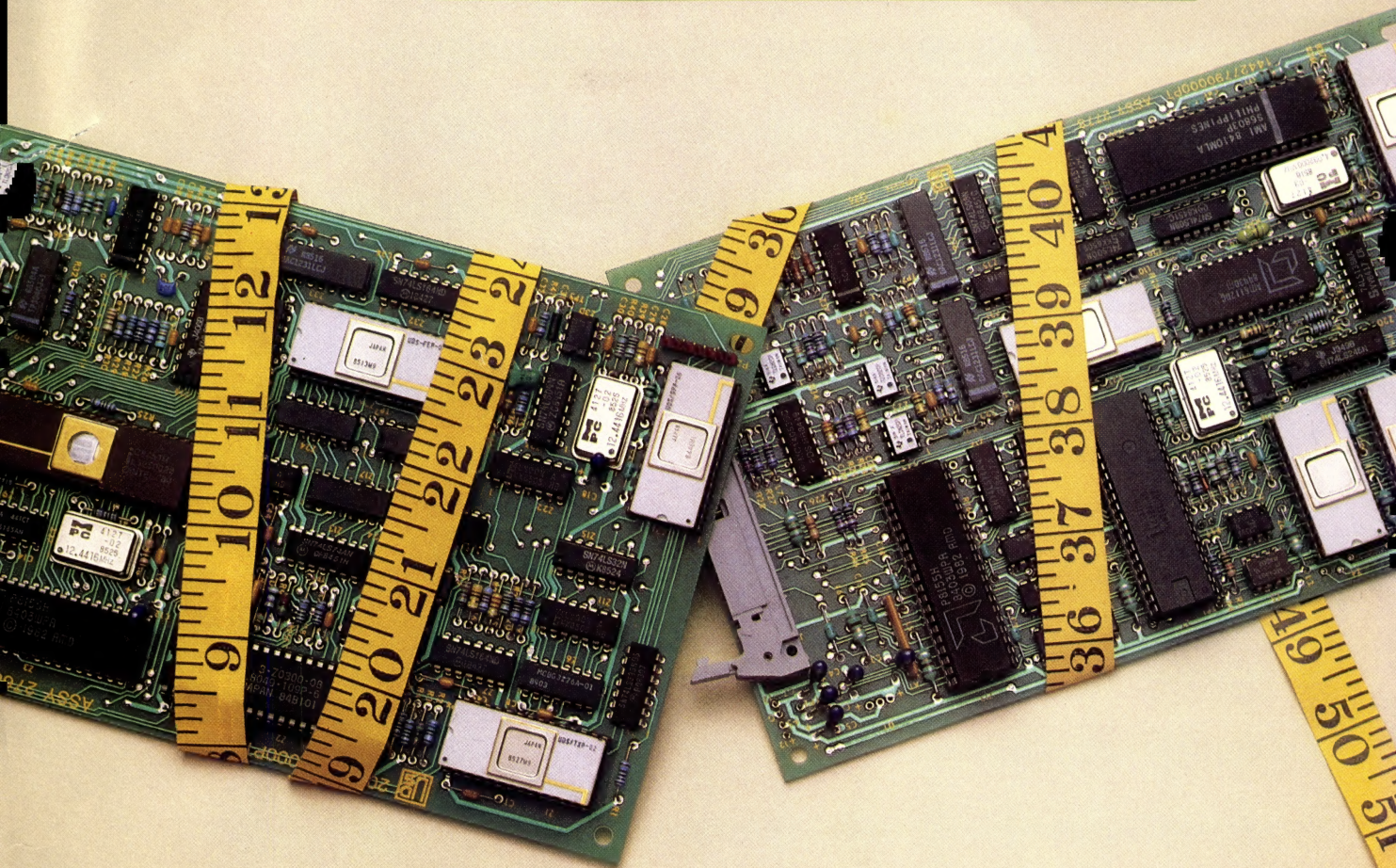
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9600FP

This UDS modem delivers 9.6kbps speed, with only 8ms turn-around time, making it ideal for fast-poll applications. A simple strap change puts the device into V.29 configuration, which includes alternative data rates of 7200 and 4800bps.

14.4 Trellis Coded

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These new OEM modem cards are small wonders! For technical details and quantity prices, contact Universal Data Systems, 5000 Bradford Drive, Huntsville, AL 35805. Telephone 205/837-8100. Telex 752602 UDS HTV.

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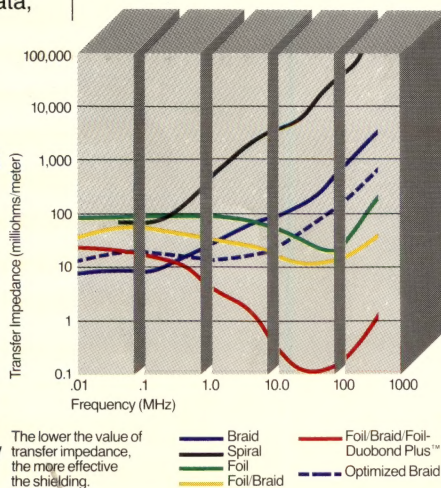
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Belden helps you control interference and protect signal integrity with innovative shielded cable

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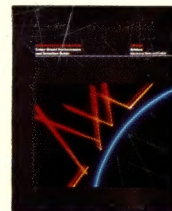


Test Methods Protect Your System

To help you define interference problems, Belden's Technical Research Center evaluates the development, implementation and refinement of shields and shield effectiveness testing. Our Transfer Impedance Test is but one of many rigorous tests employed by Belden engineers. The procedures we use help you select the proper shielded cable that results in cost-effective system performance.

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Belden has recently published a *Cable Shield Performance and Selection Guide*. It's free, and it helps you define your interference problem, acquaints you with current FCC regulations, and familiarizes you with the trade-offs associated with different shield designs and Belden's various test procedures for measuring shielding effectiveness. Shield performance results are detailed from each test to properly guide your cable selection.



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